POWER

A McGRAW-HILL PUBLICATION—ESTABLISHED 1884
ELY C. HUTCHINSON, *Editor*

Volume 74 NEW YORK, JULY 7, 1931 *Number 1*

Repeat Orders

"IT IS NOT this machine that I am so anxious to sell you," declared an intelligent salesman to a prospect. "It is the one that you are going to buy next time."

A business that enjoys frequent repeat orders has a better future in sight than one that lives on its repairs.

And yet instances are not infrequent of machines, apparatus and appliances that are sold at prices not sufficiently above the cost of their production to maintain a prosperous business were it not for the sale which their use entails of paid service, repair parts and accessories.

The man who is building a business based on an abundance of satisfied users cannot jeopardize its continuity by furnishing anything that will not show a clean record of dependable and economical service when it comes to renewal or extension.

And if he expects to get a living price for future orders, he will not sell the first at a sacrifice just to get a customer started.

If the buyer is of the sort to whom price means more than sterling worth and studied adaptability to his needs and service, the scale set by the trial order will be there as an obstacle to his own salesman and as an advantage to the "just-as-good" competitor whenever another order is to be placed.

The cheap but shoddy may win on first sales, but the lasting and successful business is based on making something so good that the user will not have anything else, and selling it at a fair profit.

F. R. Low

EDITORIALS

We Need Advanced Diesel Development

AN INTERESTING EXPERIMENT, the hypnotizing of a chicken by holding it firmly with head to the floor while drawing a chalk line outward from its bill. The fascination of watching the chalk line causes the fowl to lose all sense of its surroundings and even its equilibrium.

Not that the diesel engine manufacturer is like a chicken. There is probably no business better equipped by personnel and inherent capacity. Yet there are precious few other builders of machinery who sense so little the true value of industrial co-operation. Many of the companies seem so intent upon their own chalk lines —are so busily engaged in paddling their own canoes in their individual ways—that they lose the perspective of what is going on about them.

They seem to be such individualists they do not know, or forget, they are the components of a great diesel engine industry with a potential development that needs only their co-operation to bring an activity and scope of usefulness to diesel engines in this country at least as great as that in Europe.

As long as the American manufacturers continue their separate ways, and do not do more thinking and adopt more policies based upon the broad viewpoint of the industry as a whole, they will continue to be the victims of their wiser brethren across the Atlantic.

There are many legitimate activities that result from collective thinking which will eliminate waste and give forward impetus to the industry. Were evidence of the general interest of engineers, in diesel engines, needed, the report of the Madison meeting of Oil and Gas Division of the American Society of Mechanical Engineers, appearing elsewhere in this number, will give ample answer.

If the Navy is to use engines of American manufacture, not built in its own shops, something must be done. If the public utilities are to freely adopt diesel engines for those classes of service to which they economically belong, something must be done.

If stationary diesel engines are to generally acquire their deserved popularity in places where they best meet the conditions, something must be done.

In America as a whole, diesel business policy and designs for land and sea are not keeping pace with the times.

Why do not the diesel manufacturers take their task in hand as an industry and do it? The opportunity is both ripe and pressing.

Is It Turbulence That Helps Burning of Pulverized Coal?

MOST ENGINEERS have taken it for granted that turbulence is the key to the successful burning of pulverized coal. This idea has perhaps arisen from an apparent analogy with gaseous combustion. Turbulence brings the oxygen supply closer to the gas to be burned, and leaves less work for diffusion. But, as has been pointed out by many engineers, solids do not diffuse. Even the fine particles of pulverized coal possess no innate capacity to move themselves through the surrounding gas, except as they may fall very slowly by the action of gravity. Turbulence, in and of itself, does not solve the major problem—that of producing relative motion between the coal particle and the gas immediately surrounding it.

Yet turbulent burners have been notably successful in burning powdered coal at high rates of combustion. What is the explanation?

According to T. F. Hurley, who recently addressed the Institute of Fuels, Great Britain, the success of turbulent burners is due not at all to the turbulence, but is rather an accidental byproduct. To prove his point he constructed an experimental furnace designed to produce practically no turbulence. In it he burned pulverized coal at the rate of 500,000 B.t.u. per cubic foot per hour. This fact is decidedly interesting, but still more so is Mr. Hurley's explanation.

Before arriving at the design of this experimental furnace he sought to emulate the stoker, which holds the fuel stationary while the air sweeps by. Gravity serves

for the stoker, but its effect is very feeble in the case of pulverized-coal particles.

Then Mr. Hurley realized that centrifugal force might produce the effect of a magnified gravitational force in pulverized-coal furnaces as well as in cream separators.

Mathematical studies along this line led to the design of an experimental furnace which provided an annular space between two coaxial cones. Coal and air are admitted tangentially at the periphery. The mixture swirls around in a smooth spiral with practically no turbulence, the gases finally leaving by a central opening.

The strange thing about this burner—strange, although strictly in accordance with Mr. Hurley's theory—is that the coal particles do not pass inward beyond a certain radius. Apparently there is a balance, between centrifugal forces and the inward drag of the gas, which holds the pulverized coal radially stationary in the form of a rotating cylindrical shell, through which the gases pass just as they do through the fuel bed of a stoker.

According to Mr. Hurley, a similar effect is to some extent produced in all successful turbulent burners, whether consciously sought by their designers or not.

With such telling argument and interesting demonstration, this new theory is certainly worthy of the careful consideration of American engineers.

The Key to Improved Information On Water Supply

RAINFALL in a given period is, with our present knowledge of precipitation cycles, far from accurately predictable. The intricate relation of rainfall to runoff is not satisfactorily understood. Until these problems are solved, hydro plant operation will, with few exceptions, involve a large element of uncertainty.

Attempts have been made to predict precipitation cycles by studies of sunspots, tree ring growths and by other means. But these investigations are still embryonic and have not yet produced practical results, except possibly in a few isolated cases. The methods will have to be greatly extended before they can be successfully used for long-range precipitation predictions.

Although it may never be possible to predict rainfall over long periods, the art of hydro plant design will be greatly aided if the relation between rainfall and runoff can be established.

After a protracted drought, when ground water has been depleted, the runoff for a given amount of precipitation may be less than fifty per cent of what it would be in a wet season. Study of records of ground-water level gives hope that many of the variables affecting runoff determinations can be eliminated and the problem greatly simplified by establishing a relation between rainfall, runoff and ground water. Provision for ascertaining ground-water levels in wells can be made at comparatively low cost, and these records can be combined with those of rainfall and runoff as now maintained at many hydro plants. Such records maintained and properly analyzed over a period of years may be the key to the information now badly needed on water supply.

Welded Piping for High-Temperature Lines

WELDING was not reliable enough, some thought, to be used in the construction of steam boilers operating at moderate pressure. Now it bids fair to replace riveting entirely for boiler drums operating on the highest pressures, because riveted joints become unwieldy and impracticable with the very thick plates required.

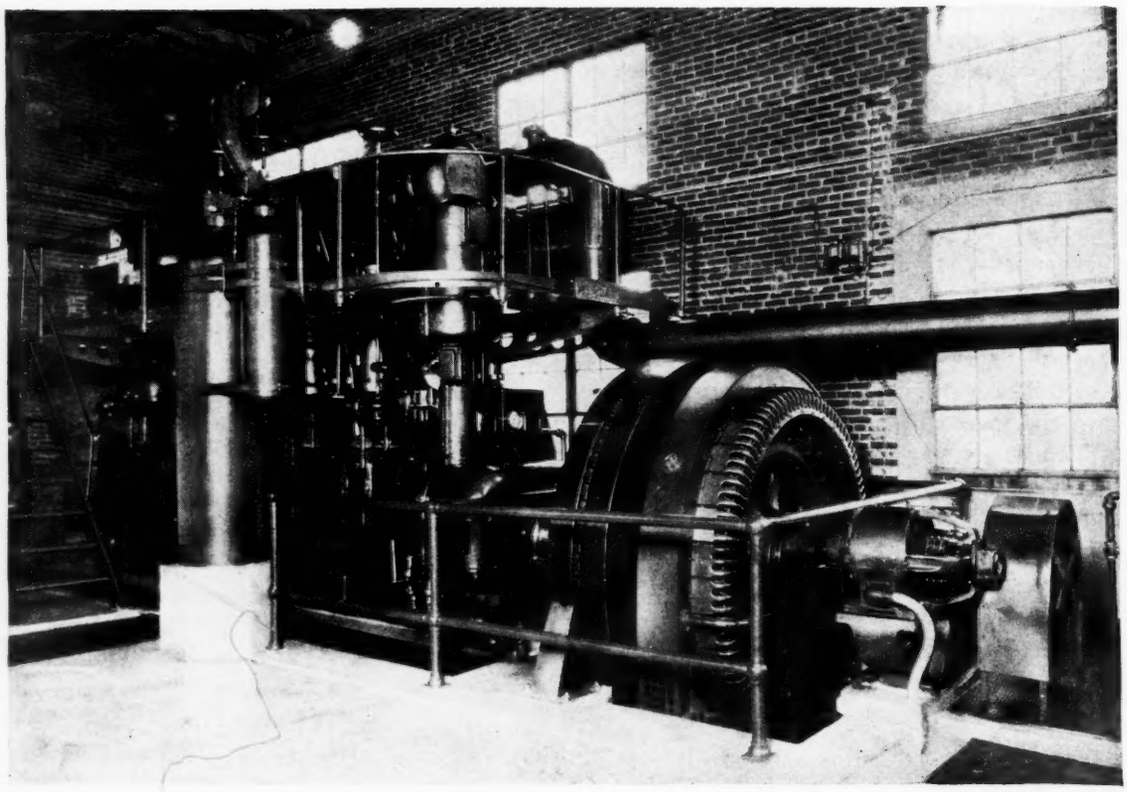
Moreover, fusion welding was frowned upon, and still is by many, for joining piping used to convey steam even at moderate pressures and temperatures. Here again welding may stage a spectacular victory. As steam pressures and temperatures have gone up and up, flanged joints have become a major problem. Flanges have become thicker and their diameters larger, bolts and studs heavier. Alloy steel has been found necessary. Their creep, and stretching caused by differential expansion, have kept designers and operators on the jump.

"If flanges give trouble, eliminate the flanges." For this most difficult of all piping services, welding is being proposed and tried. It is another case of cutting the Gordian knot.

In fact, one wonders whether practically all flanges may not be eliminated on high-pressure, high-temperature lines if a real effort is made in that direction. Steel valves, designed for the purpose, can be welded directly to piping. Welding fittings are available. It should even be possible to weld connections of turbines and boilers directly to the line. This suggestion is admittedly radical, but it is one possible solution of flanged joint troubles which may otherwise be expected to increase as more plants try to combine pressures ranging from 400 to 1,400 lb. with high temperatures.

POWER Stands for . .

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**



500-hp. unit viewed from generator end

Modern Diesel Equipment Reduces Power Cost

AT WINTERSET, IOWA

By C. F. LAMBERT
Burns & McDonnell Engineering Co.
Kansas City, Mo.

WINTERSET, IOWA, is an inland town, of 2,900 people approximately 40 miles southwest of Des Moines, which has operated its own water and light plant for a number of years. A year ago it was faced with the necessity of making extensive improvements in its municipal power plant in order to supply the increasing demand for electrical energy. The existing plant was built in 1922 and was designed for steam operation, with two engine-driven alternators of 210 and 315 kva. and two 1,500- and one 2,500-sq.ft. boilers. The largest boiler was capable of operating at 180 lb. pressure and was equipped with a stoker, while the smaller boilers were hand-fired and had an allowable pressure of 137 pounds.

Operating costs were higher and fuel requirements were greater than they should have been compared with modern plants. In addition, the plant was unable to handle its peak load effectively, and the annual consumption of electrical energy per customer was only about 40 per cent of the average consumption for a group of Midwestern communities similar to Winterset. The result was that our engineers were called in to make a survey and report on the situation.

The problem of supplying adequate electrical service at a reasonable cost resolved itself into a study of methods of generation, giving particular attention to the existing facilities. Two methods of generation were compared; one was the installation of a steam turbine and a new boiler, both operating at 250 lb. pressure with or without superheat; the other the installation of a diesel-generator unit. With the diesel plant the largest steam-driven alternator in the plant would be maintained for stand-by service.

Studies of the city's requirements showed that a unit of about 500-kw. capacity would be desirable. However, as plants of this type experience rapid growth, it was decided also to consider a unit of 750-kw. capacity.

The following four plans were considered:

(1) Steam turbine, condensing, no superheat.
(2) Steam turbine, condensing, with superheat.
(3) Steam turbine, non-condensing, without superheat.
(4) Oil engine unit.

The plans for the steam plant included a new 3,000-sq.ft. stoker-fired boiler and, if condensing, a surface condenser and spray pond.

The oil-engine plan included a waste-heat boiler for maintaining steam in the oil boilers for reserve. The estimated first cost and cost of operating for each plan are given in Table I, the operation being based on an assumed output of one million kilowatt-hours annually.

TABLE I—COMPARISON OF ESTIMATED COSTS

	Plan 1		Plan 2		Plan 3		Plan 4	
Capacity, Kw.	500	750	500	750	500	750	500	750
Installation cost	$61,860	70,600	63,435	72,176	48,262	53,197	65,604	90,431
Installation cost per kw.	123.72	94.13	126.87	96.23	96.52	70.93	131.21	120.58
Production cost, yearly	21,070	21,070	20,038	20,038	28,848	28,848	13,410	13,410
Production cost per kw.-hr.	2.1c	2.1c	2.0c	2.0c	2.88c	2.88c	1.34c	1.34c
Total operation	$27,870	27,870	26,838	26,838	235,648	35,648	20,210	20,210
Operation cost per kw.-hr.	2.79c	2.79c	2.68c	2.58c	3.56c	3.56c	2.02 c	2.02c
Total annual cost, including interest and depreciation*	$40,374	41,227	39,496	40,349	46,926	47,419	34,410	35,985
Total cost per kw.-hr.	4.03c	4.12c	3.95c	4.03c	4.69c	4.74c	3.44c	3.60c

* The fixed charges include interest on a small issue of outstanding bonds and depreciation on the entire system.

It was decided to take bids on both sizes of units and on both steam and diesel equipment. Separate bids were invited for furnishing and supervising the installation of one 500-kw. turbine-generator and switchboard on purchasers' foundation, for furnishing and supervising the installation of one 750-kw. turbine-generator and switchboard on purchaser's foundation, for one surface condenser with auxiliaries installed on purchaser's foundation, for furnishing and erecting complete one 3,500-sq.ft. water-tube boiler unit with superheaters and brickwork on purchaser's foundations, and for furnishing and erecting complete one mechanical stoker for the boiler.

In addition, bids were asked for furnishing and supervising the installation of one diesel engine unit, direct connected to a 500-kw. generator with exciter, switchboard and all auxiliaries on purchaser's founditions; and for furnishing and supervising the installation of one diesel engine unit, direct connected to a 750-kw. generator with exciter, switchboard and all auxiliaries on purchaser's foundations.

The bids received for diesel engines are tabulated in Table II.

The cost of foundations, spray pond, wiring and other details required in addition to the equipment was estimated as $17,710 for the 500-kw. and $20,250 for the 750-kw. steam plant. The auxiliaries for the diesel plant totaled $8,770 for the 500-kw. and $10,125 for the 750-kw. units.

Adding these amounts to what was considered the best bid in each type gave the results shown in Table III.

While the larger units were found to be considerably cheaper in cost per kilowatt, the officials decided they did not desire to make the larger investment at that time, so the larger units were eliminated. The economy of the diesel engine was greater than that of the steam plant, and with the attractive prices offered there was very little doubt as to the proper choice; so diesel equipment was decided upon. Much interest was shown in the one McIntosh & Seymour unit with a supercharger, and while it was recognized that the engine itself was smaller than others, it appeared to be the best offer and was accepted.

Many municipal electric light plants have failed by reason of their antiquated equipment. Others find operating costs high until more modern generating units are installed. This was the situation experienced by Winterset, Iowa, where a diesel engine materially lowered the cost of power generation.

The supercharger is a Roots blower rated at 2,610 cu.ft. of free air per minute against 4 lb. pressure when running at 315 r.p.m. It absorbs approximately 59 hp. and is driven by a Texrope drive from a sheave on the extension shaft.

The unit was installed and was tested with the supercharger on Aug. 27, 1930, operating on the city load, with an average load factor of 40 per cent, giving an output of 200 kw. The results were as follows:

Average kw.-hr. per gal. of fuel oil	8.8
At 91 per cent generator efficiency the load was, hp.	294
Fuel consumption per kw.-hr., lb.	.49

The load varied from 75 kw. to 300 kw. during the test, due to fluctuations in the demand.

The temperatures during the test were:

Atmosphere, deg. F.	75 to 85
Water in pond, deg. F.	97
Water discharge from engine, deg. F.	108
Crankcase temperature, deg. F.	132
Lubricating oil temperature, deg. F.	132
Generator temperature	Normal

The reading of conditions affected by the supercharger were:

Intake temperature, deg.	75
Discharge side, deg.	85
Supercharger discharge temperature, lb.	3.87
Engine exhaust pressure, lb.	0.87

The engine ran smoothly and with clear exhaust during this test period. It was also operated on full load of 500 kw. for short periods, but because of the switches heating up it was impossible to run long enough to check the performance with accuracy.

On Aug. 28, after changes had been made in the water rheostat and the wiring on the switchboard, the engine was operated at full load and 10 per cent overload.

During the full-load test the load was carried on a water rheostat. Because of this arrangement the water temperature during test was a little above normal.

The fuel consumption was 1 gal. of oil per 11 kw.-hr. At 93 per cent generator efficiency, the 500-kw. gave

TABLE II—DIESEL ENGINE BIDS

	No. 1			No. 2		No. 3			No. 4		No. 5		No. 6
Bidders	a	b	c	a	b	a	b	c	a	b	a	b	a
Hp. rating	675	750	1,125	800	1,075	720	865	1,060	810	1,080	750	1,200	750
No. cylinders	6	4	6	6	8	7	6	8	6	8	6	6	5
Cylinder bore, in.	17	22	22	14¾	14¼	17½	17½	17½	18	18	17	23	16
Piston stroke, in.	24	30	30	18	18	25	25	25	25	25	24½	28	20
R.p.m.	240	180	180	277	267	225	225	225	225	225	225	200	257
Fuel per kw.-hr. lb.													
Full load	0.62	0.62	0.62	0.67	0.67	0.645	0.64	0.63	0.605	0.605	0.605	0.60	0.60
Three-quarter load	0.68	0.62	0.62	0.71	0.71	0.66	0.655	0.64	0.626	0.622	0.635	0.631	0.635
Half load	0.69	0.63	0.63	0.81	0.81	0.714	0.705	0.69	0.710	0.705	0.700	0.695	0.695
Bid price	$44,000	$52,600	$68,000	$46,530	$57,455	$37,790	$43,625	$48,965	$43,718	$60,573	$40,275	$67,140	$39,250
Cost per hp	$62.20	$70.00	$60.50	$58.00	$52.50	$52.50	$50.50	$46.00	$54.00	$50.50	$53.70	$56.00	$52.50

Winterset, Iowa, municipal Diesel plant is housed in an attractive building

a brake load of 720 hp., making the fuel consumption per brake horsepower-hour 0.48 pound.

Although this is somewhat above the fuel consumption guarantee, the engineers believe that the fuel economy will be much better as soon as the engine is in operation long enough to loosen up the bearings and polish the cylinder and piston walls. With the facilities on hand, it was also impossible to keep a steady load on the engine during the test, the load varying from 490 to 550 kw.

It was impossible to make a heat test on the waste-heat boiler, as this unit was not connected up to the steam boiler.

Operating data for October, November and December, 1930, showed a substantial saving over the same period during 1929, when the steam equipment was used. There was no forced shutdown of the diesel unit, but an inspection was made every three weeks, and during that time the steam equipment was used.

A comparison of the three months of 1929 with 1930, including the coal used for the steam engine during the inspection periods and that used for building heating, is given in Table IV.

During this time the waste heat boiler was not in operation. Had this been in operation the cost of diesel generation would have been reduced by approximately 0.25c. per kilowatt-hour.

As the total kilowatt-hours for three months was 291,610, the savings during this period were $2,391.20, or at a yearly rate of $9,564.84. This saving will increase as the load increases and the operation of the diesel engine becomes more economical.

TABLE III—BEST BIDS ON EQUIPMENT

	Steam Plant	
Capacity, kw	500	750
Turbine	$18,400	$22,743
Condensers	6,345	8,095
Boiler	10,807	10,807
Brickwork	4,045	4,045
Stokers	6,618	6,618
Other items	17,710	20,250
Total	$63,925	$72,558
Cost per kw	$127.95	$96.74

	Diesel Plant		
Capacity, kw	500	750	500*
Engine	$43,625	$60,573	$37,790
Other items	8,770	10,125	8,770
Total	$52,395	$70,698	$46,560
Cost per kw	$104.79	$94.26	$93.12

* Equipped with supercharger.

The steam equipment ran just slightly over the estimate and the diesel equipment considerably under the estimate, largely due to very active competition among the diesel manufacturer.

TABLE IV.—OPERATING COST

	Steam Operation, 1929			Steam and Diesel Operation, 1930		
	Oct.	Nov.	Dec.	Oct.	Nov.	Dec.
Kw.-hr. generated	80,910	78,880	87,150	94,660	91,750	105,200
Coal, tons	251	249	292	83	58	38
Fuel oil, gal	.....	.....	.....	9,454	10,250	11,668
Fuel cost	$1,295	$1,285	$1,507	$815	$743	$723
Labor cost	450	450	450	350	350	350
Lubrication cost	.....	.....	.....	20	20	20
Production cost	$1,745	$1,735	$1,957	$1,185	$1,113	$1,093
Production cost per kw.-hr., cents	2.16	2.20	2.24	1.25	1.21	1.04
Fixed charges per kw.-hr. (new equipment), cents	.....	.....	.....	0.54	0.49	0.38
Total cost per kw.-hr., cents	.....	.....	.....	1.69	1.70	1.42

▼

EXHAUST TURBINES FOR SHIPS

IN RECENT YEARS the geared turbine has made possible a development which is of particular interest to shipowners operating reciprocating-engined vessels. This is the combination of an exhaust-steam turbine with a reciprocating engine, both driving the same shaft, as in the Bauer-Wach system. By this arrangement from 25 to 30 per cent more power can be provided with no additional expense for fuel, resulting in an increase of a knot in speed for an average vessel, or a saving of something like 25 per cent in fuel can be made with the combination machinery while developing the same power and speed that could be obtained from the reciprocating engine alone. Whether increased speed or lower fuel consumption is desired, the advantage of utilizing the combination machinery is an attractive one for the shipowner, especially as the exhaust turbine can be installed on existing vessels in a relatively short time and at small cost as compared with the installation of new machinery.—*Marine Engineering.*

Oil and Gas Power Division A.S.M.E. Holds Fourth National Meeting at Madison, Wis.

THE DIESEL for electrical generation, as a primary drive for various types of equipment, for the motor truck, the locomotive, and for ship propulsion, was featured at the fourth national meeting of the Oil and Gas Power Division of the American Society of Mechanical Engineers. The meeting was held in the new mechanical engineering building of the University of Wisconsin, Madison, Wis., dedicated on the day preceding the opening of the meeting. From June 23 to 26, inclusive, a comprehensive program, consisting of sixteen papers and two committee reports, with full discussion, was presented. Consideration was given to trends in diesel design in Europe and America, with special attention to double-acting diesels and the automatic diesel-electric plant. Results from existing plants were made available. There were papers on the dispersion of oil sprays, combustion chamber design, flow of air through engine valves, the use of light alloy pistons and rods, the piston packing problem, and heat recovery from jacket water and the exhaust gases.

In the laboratory of the building an interesting exhibit of engines for stationary and marine use, accessories and supplies, had been assembled. Features showing the diversity of application were small high-speed diesels for stationary service; a new L-head diesel; a diesel-motored truck; a diesel-electric car of the Chicago, Milwaukee, St. Paul & Pacific Railway; a nine-cylinder, four-stroke-cycle, air-cooled, 225-hp. Packard diesel aircraft engine; and the Cummins diesel-motored racing car that participated in the recent races at Indianapolis.

Total attendance approximated 300. The general program included entertainment and dancing on the evening of the opening day, a banquet on Thursday evening and a trip to the Dells of the Wisconsin Friday afternoon. On Thursday a special train carried the entire group to Beloit for luncheon and an inspection trip through the works of Fairbanks Morse and Company.

Dispersion of Sprays in Solid-Injection Oil Engines

● At this session an instructive paper on dispersion of sprays in solid-injection oil engines was presented by Kolman J. DeJuhaszy, assistant professor of engineering research at Pennsylvania State College. The author pointed to the twofold division of the fuel charge. First it must be atomized, and, secondly, the small particles of oil must be mixed with and evenly distributed in the combustion air. Atomization is the essential prerequisite of complete and rapid burning. Dispersion is a fundamental requirement for low fuel consumption and high mean effective pressure. In low fuel consumption the solid-injection oil engine is superior to the carburetor engine and the air-injection diesel, but in high mean effective pressure, it lags sadly behind, owing to the lack of satisfactory combustion control. It is in the improvement of this control, with which the processes of atomization and dispersion are closely connected, that the future progress of the solid-injection oil engine and its entrance into new fields of application depend.

As improving atomization and dispersion involves a knowledge of the mechanism of spray formation, the author reviewed the few theories existing that might serve as a background and eventually entered into the experimental methods that had been adopted in the laboratory to determine the spray characteristics that are of interest from the engine-performance point of view. The characteristics of the spray, including its dispersion in space, depends on three sets of factors, namely: fuel factors, comprising oil pressure, specific gravity, viscosity and surface tension; nozzle factors, comprising size and shape of the channels and apertures through which the fuel passes; combustion-air factors, involving its density (pressure temperature), and its state of stagnation or agitation. At the Engineering Experiment Station of the Pennsylvania State College a general research is being

The new mechanical engineering building of the University of Wisconsin was the scene of the fourth national meeting of the A.S.M.E. Oil and Gas Power Division

carried out on the dependence of spray properties upon the foregoing governing factors. Data obtained point to the following general conclusions:

Dispersion becomes more even when the injection pressure is increased, when the oil viscosity is decreased or when the air density is increased.

The cone angle increases with increasing oil pressure, increasing air density and decreasing viscosity of oil.

A larger percentage of oil reaches a given distance in a spray having a slenderer spray cone.

No definite trend was noticeable in using cylindrical orifices of the dimensions employed in the tests.

Whether to use sharp-edge or round-edge orifices was a question coming up in the discussion, which was settled in favor of the latter, sharp edges would soon wear round from the erosion of the oil. Orifice coefficient of 96 and 98 per cent only left a small amount of energy for turbulence to break up the jet into spray, but in a solid-injection system the actual energy required is extremely small, amounting to something like 0.03 of 1 per cent of the energy in the fuel jet. Other points brought up were the action of the fuel when sprayed into a vacuum and into water, the part played by air resistance in atomization, injection pressure, injection periods and uniformity of dispersion.

The Quiescent Combustion Chamber

● As explained by John A. Spanogle in his paper on "The Quiescent Combustion Chamber," the term "quiescent" originated as describing more accurately than "non-turbulent" the condition of the combustion chamber at the time of injection of the fuel. Back of it is the thought that turbulent flow is not suited to the requirements of the fuel-injection engine, and that better results may be obtained if the flow is orderly and reproducible for every individual engine cycle.

Material for the paper was obtained from performance tests of a single-cylinder unit in the general program of the National Advisory Committee for Aeronautics in investigating the compression-ignition fuel-injection engine as a source of power for aircraft. The simplest combustion chamber is the quiescent one, and the simplest injection orifice is the round hole, so that the main tests were directed toward obtaining the optimum combination of these two elements. Orifice areas were considered in single-stem and double-stem fuel-injection valves. Results from supercharging tests and rates of injection received comment, and indicator diagrams were analyzed to check performance and to show trends and tendencies that can be determined in no other way.

The author considered the control of distribution and the control of combustion as the two great factors in obtaining improved performance. For the distribution of the fuel to the air in the quiescent combustion chamber by means of multiple-orifice injection nozzles, the tests, in his opinion, give a principle that may be followed in the design of the nozzles and show some of the difficulties encountered. For the control of combustion the tests give indications of the possibilities for control of rate of pressure rise through the control of rate of combustion, and show that the rate of fuel injection is not particularly important in influencing the rate of combustion, and therefore the rate of pressure rise for high-speed operation.

The quiescent combustion chamber vs. the combustion chamber with air flow became the topic for discussion. One participant wished to know if a fuel economy of 0.6 lb. per horsepower-hour given in the paper was representative of the former, whereas 0.45 to 0.4 lb. could be obtained with the turbulent combustion chamber, and as low as 0.35 lb. with the swirling-air chamber. The 0.6, of course, was representative of the engine used in the tests. The author mentioned the difficulty of measuring air velocity under changing air pressures and temperatures. At present too little is known about air velocity and its effects on combustion.

Experiments on Flow of Air Through Engine Valves

● Experiments on the flow of air through engine valves had been made and the results reported in a paper by E. S. Dennison, T. C. Kuchler and D. W. Smith, all of the Westinghouse Electric & Manufacturing Company. The resistance of air flow through poppet valves was obtained in both inlet and exhaust directions, and the ranges of valve opening and of pressure head extended to or beyond the limits normally used in practice. Individual valves were tested variously mounted, and pairs of valves were tested as grouped in actual design. The experiments were extended in an effort to improve the flow characteristics of the poppet valve, including standard, "drop" and "tulip" types, by modification of its shape and that of the valve approaches.

Conclusions reached were to the effect that inlet valves of conventional types perform in engine assembly approximately as they do in model tests, so that the results are suitable for design purposes. Exhaust valve tests in models are misleading unless the possible extent of diffuser action is known and understood. Results with exhaust valves mounted in the cylinder head are preferable in design data. Improvements in valves may be effected by designing the flow path as a diffuser, which may be done locally at the valve head and seat or in the passage above the valve, or in both ways. The former method is effective both for inlet and exhaust, the latter for exhaust only. Preferably both methods, in the opinion of the authors, should be combined in the exhaust valve and passage design.

Discussion turned to the desirability of standard methods, so that the data from tests made by different authorities might be comparable. F. G. Shoemaker outlined the plan of procedure at Wright Field, where wooden or iron models on the actual cylinder were employed. To eliminate the velocity effects of varying cylinder designs, the differential impact of the air between the entrance pipe and the cylinder barrel was obtained. In other words, they measured the mean impact head. The flow was carried up to the critical pressure and measured in cubic inches per minute per cubic foot of piston displacement. From the flow data time area diagrams were plotted.

Diesel Fuel Research Committee

● Wiley Butler, secretary of the Diesel Fuel Research Committee, made a report of progress, indicating that nothing had been done during the past year, owing to the recent development of the high-speed diesel engine, and the desire to avoid duplication of work by committees of the society, the American Society of Testing Materials and the Association of Automotive Engineers. Joint committees were organized and a few days ago had their

first meetings to schedule the work. A three-year program of research on the future diesel fuel oil specifications and the future engine itself will be conducted under the direction of Doctor Dickinson of the Bureau of Standards. The practical work in the field obtaining results from different fuels used in engines operating under varying loads will be continued by the society's committee.

If the large diesel is to compete with steam, it was Mr. Butler's contention that a cheaper fuel must be used. Distillate must be blended with the residues of the distilling process, and full data obtained on the use of these new fuels.

Oil Engine Power Cost

● Following, M. J. Reed submitted the report of the sub-committee on Oil Engine Power Cost, which contained data from 81 oil-engine generating plants with an aggregate of 253 engines totaling 146,865 rated brake-horsepower. All but one of the plants are in the United States, and the engines are principally of the full-diesel vertical type. In tabular form the committee presented complete data on production cost, lubricating oil, fuel oil, maintenance and operating labor, ad invested costs. Figures on fuel and lubricating oil economy also were given in graphic form.

Items suggested by the committee for the 1931 questionnaire are: number and total duration of enforced shutdowns; duration of peak loads; liner wear; supplies and repairs; investment cost, including land, building and equipment; and definitions for the type of load.

Selecting a Diesel Engine

● As intelligent selection of a diesel engine is not easy, Otto Nonnenbruch, chief engineer of I. P. Morris & De La Vergne, Inc., was requested to prepare a paper that would help clear up some of the things that disturb the purchaser and react to the detriment of the industry. In selecting the manufacturer he recommended that the purchaser should look beyond the prices quoted and realize that he is spending money, not to get an engine, but to generate power reliably and at low cost over a long period. The manufacturer's experience, achievements and reputation, therefore, should be the main deciding factors, and not price or hypothetical technical advantages.

Of all the questions that arise in purchasing an engine, the author considered selection of type as the one least accessible to precise analysis. Requirements of the application in certain cases give the answer, but, in general, the following facts stand out: The greatest assurance of success lies not in the type of engine, but in the details of design, materials and workmanship proved by the engine's record or by the manufacturer's reputation. Crowding a high horsepower rating into a given engine lowers the cost per horsepower and shortens the life of the engine. Therefore an engine should be as conservatively rated in speed and mean effective pressure as the purchaser can afford to use. There should be as many cubic feet of cylinder displacement for a given horsepower rating as the application and the price permit. The design of the engine should be as simple as possible. Specifications should contain only points essential to the purchaser, such as weight and space limitations. They should not dictate type or details of design. Tabulation of bids are necessary records that do not help much in determining the quality of engines.

Among the various technical points that are frequently misjudged, the author commented on horsepower rating, main bearings, bearing pressures, cylinder liners, pistons, wristpin bearings, camshaft drive, governors, lubrication, water cooling, weight and the fuel consumption. The item last named he considered of great consequence, as it represented approximately one-half of the total operating cost. Only guarantees made on the same basis are comparable. Such basis can be a shop test witnessed and checked by the purchaser. The stipulations should be that the fuel consumption be reduced to a fuel having a high heat value of 19,000 B.t.u., and that a tolerance of 3 per cent be applied to allow, not for errors, but for the new and still engine, also that no special adjustments, impracticable for actual service, be resorted to, and that maximum combustion pressures be held to those specified for the engine.

In the discussion it was brought out that good conservative engine practice of today required 100 per cent excess air. All that an engine buyer has to do to assure himself that his engine is designed according to established practice is to take the fuel rate in pounds per brake horsepower-hour and multiply by the mean effective pressure. This should give a figure ranging from 30 to 32. For cooling water a good average figure is 12 gal. per horsepower. For engines used in construction work better facilities for keeping the fuel and lubricating oils clean were desired. The author expressed cylinder liner wear in thousands of an inch per million revolutions. The more common way is to give the wear in thousands of an inch per 1,000 hr. An essential point is to distinguish between the wear when the engine is breaking in, and, later on, as the rate may be excessive, at the start. It was the consensus of opinion that if the diesel engine is to survive, particularly in the large marine field and the locomotive, where it has been losing out of late, the power output per dollar of investment must be increased.

Development of a High-Speed L-Head Diesel Engine

● Several papers were devoted to the development of diesel engines of various types. Max Hofmann, chief diesel engineer of the Waukesha Motor Company, outlined the construction and characteristics of the new Waukesha L-head high-speed diesel which was developed from a heavy-duty gasoline engine. Diesel engine designers generally, he said, consider it difficult to make an L-head combustion chamber of the diesel type, with its high compression ratio necessary for compression ignition, without unduly restricting the volumetric efficiency. Evidence was submitted to prove that it is quite possible to design such a combustion chamber with a compression ratio of about 14 to 1 and a volumetric efficiency equal to that of an average L-head gasoline engine. Tests on a 6¼x8-in. engine, operating at its rated power of 90 hp. at 950 r.p.m., showed that the ratio between actual and theoretical compression was 0.82, while the volumetric efficiency at the speed given measured 68 per cent.

Besides giving satisfactory performance, the L-head combustion chamber simplifies the valve gear and makes the cylinder head a simple casting, with the chances of cracking reduced to a minimum. Reduction in the number of parts increases the reliability and reduces the cost

of manufacture. Over-all height above the crankshaft center is reduced to about 80 per cent of that required by an overhead-valve engine of the same capacity, an important item for installations with limited headroom, such as on tractors, boats and switching locomotives.

Another important feature of the design is the high degree of turbulence that is created in the combustion chamber, making it possible to inject the fuel at relatively low pressures and still get an intimate mixture between fuel and air. Indicator diagrams from an L-head diesel engine showed that the compression pressure is held between 425 and 450 lb. per square inch, while the explosion pressure stays near 650 pounds.

Discussion on the new design turned to the prevention of carbon formation in the openings of the fuel nozzle. Factors are the filtering of the oil and the exhaust turbulence obtained with this engine. Getting rid of initial high compression in starting has been solved by the use of a relief valve. One of the participants in the discussion contended that standards of comparison with the conventional engine should have been higher. He objected to an excess air coefficient of 1.5 and to an economy in fuel consumption of 0.48 lb., when a considerably lower figure could be obtained. In the small high-speed diesel the author considered it advisable to sacrifice a little in economy to get simplicity and reliability.

Diesel Engine in Municipal Plants

● C. F. Lambert, of Kansas City, in outlining the advantages of diesel engines in municipal plants, presented a wealth of operating data from existing installations. In preparing reports on the feasibility of new plants it is his plan to include both steam and diesel plants where the output is between 2,000,000 and 10,000,000 kw.-hr. per year. Although there are many special cases with smaller and larger outputs where both types are considered, usually those plants below 2,000,000 kw.-hr. are diesel plants and those above 10,000,000 kw.-hr. are steam plants.

To show the comparison in first cost and operating cost between steam and diesel plants in a number of projects, the author presented the accompanying table. The two sets of figures under "cost per kilowatt-hour" show the

			Diesel Plant			Steam Plant		
Project	Output, Mil. Kw.-Hr. Starting	Final	Installed Cap., Kw.	First Cost	Op. Cost per Kw.-Hr.	Installed Cap., Kw.	First Cost	Op. Cost per Kw.-Hr., Cents
1	1	1	7,000	$925,000	1.30 1.47	7,000	$717,700	1.37 1.65
2	10.0	15.0	4,000	562,850	0.85 3.02	4,000	560,170	1.03 3.81
3	2.0	3.0	500	69,280	1.10 3.47	500	148,145	1.21 3.95
4	2.5	5.5	2,000	280,000	0.89 2.43	2,000	320,000	1.10 2.69
5	3.7	7.8	1,500	233,000	0.82 1.20	2,000	267,000	0.98 1.45
6	3.9	7.6	2,000	239,497	0.79 3.80	2,000	239,357	1.04 4.4
7	2.0	3.0	1,250	219,000	1.22 4.1	1,250	194,800	1.91 4.65
8	0.9	1.5	500	77,470	1.34 1.58	500	57,435	2.00 2.01
9	1.5	2.5	500	68,930	1.15 1.95	500	37,162	1.77 2.16
10	6.0	22.0	3,000	465,000	0.68 4.10	3,000	469,000	0.90 3.75
11	1.0	1.5	650	100,000	3.21 2.55	650	121,650	2.7 2.80
12	4.0	8.0	3,150	310,440	0.80 2.93	4,000	363,950	0.94 2.75
13	3.8	6.0	1,500	202,750	1.50 1.33	1,500	220,750	1.26
14	2.2	3.5	1,250	214,005	0.92 2.74	.....	.....	.... 2.75
15	7.5	15.0	4,000	462,700	0.66	4,000	427,650	0.72

plant operating costs, and the entire cost of operation including interest and depreciation on the new investment. Starting and final outputs were given, as many of these plants start as competitive plants, securing only part of the business. The possibility of acquiring the entire load in many cases became an important factor in the final decision as to the type of equipment to be installed.

In each of the cases listed recommendations were made as to the type of plant that would give best results. Other data from numerous plants in service gave the consumption per kilowatt-hour of fuel and lubricating oils and the cost of maintenance.

Referring to municipal and other isolated plants in the discussion, one great advantage of the diesel over steam plants is the high economy of the small unit. Investment costs are on a par. One type of equipment rather than the several types used in a steam plant made the diesel plant easier to finance. Its high efficiency makes it an active competitor of the transmission line, and by this competition the rates to the consumer have been lessened.

Present Position of Automatic Diesel Electric Plant

● Although automatic electric generating units driven by gasoline engines, such as farm lighting outfits, have been used widely for twenty years, the automatic multiple-unit diesel-electric power plant for high-grade service is a novelty. Gradual refinement of the diesel engine has made available engines that operate satisfactorily under automatic control, and the low cost of diesel power has instigated the construction of automatic diesel electric plants containing several units.

In a paper dealing with the present position of this type of plant, Edgar J. Kates, consulting engineer, described in particular an automatic diesel plant recently installed in the Hotel Chelsea, New York City.[1]

When the demand for diesel engines for automatic service becomes sufficiently large, the author contended that it will be worth while for manufacturers to modify their designs to take advantage of the unusual operating conditions.

Interest in this paper was indicated by the many questions asked the author. His answers disclosed a 240-volt storage battery of 360 ampere-hour capacity, an investmen 'ess than $50 per kilowatt over the cost of a manually-operated plant of the same capacity, the plant paying out on an investment basis in four years; a labor requirement of 1,200 hours per year for supervision and maintenance; and the methods employed in synchronizing and regulating an alternating-current plant.

Development of the Double-Acting Engine

● Development of the double-acting diesel engine to a reliable prime mover in less than a decade was reviewed by Louis R. Ford. In the marine field development has reached a point where double-acting engines for large power work are attracting wide attention. An indication is the action of a committee appointed to study the types of equipment offered for the extension of the electric power station at Copenhagen, Denmark, in recommending a double-acting, two-stroke-cycle engine of 18,500 b.hp., with continuous overload capacity of 22,500 b.hp. At present the two-stroke-cycle type with mechanical injec-

[1]This plant was described in *Power*, June 23, 1931.

tion of fuel is forging ahead of the four-stroke-cycle design. Mr. Ford outlined the steps in the development of the double-acting engine, enumerating the troubles that had been encountered with a large piston rod and suitable packing, location of the fuel valves without undue interference with the circulation of cooling water, mechanical-injection systems, expansion of liner and jacket, piston construction, and cooling-water connections to the piston rod.

Attention was directed to improved construction that had remedied these troubles until today the maintenance of such installations, from the author's viewpoint, offers no more difficulties than does that of the older single-acting engine. In his opinion there is no reason to assume that we have reached the limit of power that can be built into a single unit. The increasing number of power plant installations being made in Europe leads to the hope that similar applications may be seen in the United States.

Difficulties from piston-rod breakage, stuffing box trouble, cooling troubles owing to corrosion and to oil getting into the scavenging air were some of the items discussed. It was agreed that the present tendency is to use two-stroke-cycle double-acting engines for capacities over 2,000 hp. Below that there is a division between single- and double-acting machines.

Decade of Light-Weight Diesel Development in Europe

● A group of papers summarized European diesel development. From a table giving the principal design factors or characteristics of 40 modern four-stroke-cycle high-speed light-weight European engines designed by seventeen manufacturers, J. O. Huse, of the Bureau of Engineering, United States Navy Department, reviewed the accomplishments of the years 1920 to 1930. Of the engines considered the minimum size is 35 hp. per cylinder and the maximum 235 hp. None of the engines weighs more than 30 lb. per horsepower complete.

Referring to the present state of diesel engine design, the author listed the following sharply defined trends: vertical line cylinder arrangement, solid injection, aluminum uncooled pistons in cylinders up to 125 hp. and cast-iron or forged-steel cooled pistons above 125 hp., increased piston speeds, moderate brake mean effective pressures in unsupercharged engines, multiple inlet and exhaust valves and tie-rod framing construction.

Controversial factors in design are: the use of supercharging to increase the output of the smaller cylinder and to avoid the effects of valve restriction; the proper use of aluminum in stressed members and the limiting size of the aluminum-framed cylinders; the limit to the size of a cylinder using a forecomer or air reservoir and the introduction of direct solid injection; the use of individual fuel pumps or block pumps, open fuel nozzle or closed automatic nozzles; the correct limiting size of the four-stroke-cycle cylinder and the correct size at which to shift to two-stroke-cycle; the use of means to lighten the framing which interferes with accessibility, such as suspending the bearings, and using valve seats fixed in the cylinder head.

The present limit of the four-stroke-cycle high-speed light-weight engine with simple uncooled pistons, he said, is 100 to 125 hp. per cylinder. The future trend probably will increase this output to about 200 hp. per cylinder for electric locomotive and submarine use by development of a reliable, larger, uncooled, aluminum piston to eliminate cooling the piston; by increasing the piston speed and revolutions; by supercharging, or by shifting to two-cycle design.

Disregarding entirely the experimental aircraft developments, the last decade has produced a high-speed, four-stroke-cycle diesel engine, in outputs up to 120 hp. per cylinder, weighing but 20 lb. per horsepower, running at speeds of 600 to 1,000 r.p.m. and occupying less than ½ cu.ft. per horsepower. Thus in ten years the diesel has halved its weight, doubled its speed and halved its space requirement. In the same period the cost of the light-weight diesel horsepower has been more than halved.

Automotive Diesel of 2500 R.p.m.

● Repeating his effort of 1928, Oliver F. Allen, consulting engineer, portrayed trends in European oil-engine development by means of lantern slides and motion pictures taken by him in the shops and test floors of Continental and British factories. Comments on outstanding factories made reference to the many simultaneous efforts to improve combustion chambers; the increased interest in two-stroke high-speed motors, and in sleeve-valves for all types; increases in piston speeds, in rotative speeds, and in brake mean-effective pressures, combined with great reduction in weight; the effect of these developments on the cost of manufacture, availability and overall operating cost; the elimination of the air injection type, and the rapid growth of the two-stroke-cycle double-acting engine for large powers; and the fact that the 2,500-r.p.m. automotive diesel is an accomplished fact in at least two countries. A veritable flood of questions showed the interest taken in Mr. Allen's able dissertation on this general subject.

For the third paper of the session, Prof. P. Langer, of Aechen, Germany, had forwarded an interesting contribution comparing the performance of diesel and gasoline engines in motor trucks. In the tests particular attention was paid to the performance of the engines in the lowest speed ranges. Data were presented on engine acceleration, maximum pressures during combustion and road acceleration. From the results some interesting conclusions were drawn.

Light Metal Alloy Pistons and Rods in High-Speed Engines

● Following the availability of improved materials and the necessity of obtaining increased power output without sacrificing space and weight, the speed of the internal-combustion engine has been brought into a higher range. Speeds up to 1,000 r.p.m. are now common. To preserve durability and economical upkeep in these high-speed engines, it becomes necessary to reconsider some points in design and adopt better grades of material to solve the problems of higher heat stresses and increase in dynamic bearing loads. Pistons cast of steel with thinner sections have been used to reduce the weight; cylinder liners have been made thinner and cast in steel to reduce thermal stresses, and connecting rods of special alloy steels are made lighter.

According to Benedict J. Isidin, engineer with the Aluminum Company of America, the aforementioned problems, in spite of these refinements in design and materials, are only partly solved, owing to the heavy

weight and insufficient heat conductivity of steel and cast iron, and the sacrifice in rigidity of construction by using light, special, alloy-steel connecting rods. With inertia loads becoming the predominant factors in engine design, the author recommends the use of aluminum alloys of proper physical properties for the reciprocating parts. These materials, by allowing the use of heavier sections that preserve the rigidity, and removing the thermal difficulties, will permit pistons and rods to operate cooler and result in better performance. A weight saving in pistons and connecting rods of 50 and 40 per cent, respectively, as compared with ferrous materials, becomes possible.

Topics considered in the discussion were: thickness of liner vs. clearance for piston, outlet cooling water temperatures, use of low-expansion alloys in pistons, and effect of increase of length of connecting rods from heat. By increasing the compression, the longer connecting rod should tend to improve the economy. In high-speed engines inertia forces running as high as 130 times the weight are of the utmost importance. Halving the weight by the use of aluminum in the reciprocating parts has helped to solve this problem. One participant stated it would be difficult to compete with the gasoline engine unless the cost of the diesel is reduced to $15 to $18 per horsepower.

Marine Propulsion by Diesel Engines

● The competition of effiicent high-pressure high-temperature steam in marine work, said A. J. C. Robertson, of Fairbanks, Morse & Company., makes it essential for the diesel engineer to seek propeller efficiencies at least equal to those available to steam turbine engineers. Until something better than the screw propeller is invented, it means using the largest propeller, or propellers, that the dimensions of the ship will allow. A depth of water of at lease 20 per cent of the propeller diameter should exist above the propeller tips for maximum efficiency and thrust. The rotative speed should be such that pitch ratios exceeding 90 per cent be possible.

In the author's opinion, there appears to be only two ways to meet this steam competition: either the development of slow-revolution, long-stroke diesels especially for marine work, or some form of gearing with high-speed diesels. For heavy freight ships of low power, the long-stroke diesel is able to show good economy, but for vessels of relatively high power the diesel-electric or the mechanically geared diesel is logical.

In the past diesel engines for merchant ships have been heavier than reciprocating steam engines with their boilers, for equal revolutions, so that weight is the biggest limitation with which any marine architect has to contend. It has been stated that one ton added in the equipment of a ship involves an increase of five tons or more in the displacement of the completed ship if it is to perform the same duty. Extra weight means extra power for propulsion and extra fuel. For this reason any development of diesel engines (other than increasing revolutions) which produces a light engine will be welcomed by ship owners, with this important provision that the machinery must be of the utmost reliability.

Discussion centered on propeller design, the relative efficiency of single and multi-propeller ships, the effect of shallow draft on the speed and the load on the engine, relative efficiency of three- and four-blade propellers, and propeller design for towing and running free. As a solution of the diesel marine problem, pushing forward of gear reduction was considered essential.

Piston Packing Efficiency

● Piston rings and cylinder wear represent the largest expenditure in the upkeep of oil engines and compressors. To maintain the mean effective pressure and the over-all efficiency, many problems are encountered. To assist in their solution C. E. Sencebaugh, of Fort Worth, Texas, presented a paper covering the evolution of the piston ring, and the design and construction of plain right-angle, miter, scarf and stepped rings, and a number of multi-piece types. The materials that have been used, such as cast iron, nickel, bronze, steel and alloy steel, were compared. Wear was discussed in relation to piston speed, revolutions, heat and pressure stresses and the position of the first ring. Under lubrication, quality, quantity and method were covered, and in taking up factors of operation such items as temperature, pressure on the rings and back of the rings, and the initial ring tension were considered.

In the discussion it was not agreed that one type of ring would be suitable for all operating conditions, as the paper seemed to infer. For example, the two-piece ring with top groove did not always work out. There were comments on the different types of ring mentioned in the

Some of the delegates to the fourth national meeting of the Oil and Gas Power Division of the A.S.M.E.

paper, and one member gave the leakage losses for the various types. A mooted question on which there was a division of opinion was the advisability of counterboring the upper end of the cylinder.

An Outstanding Municipal Diesel Power Plant

● A paper by C. Ruegg, chief diesel designer of the Nordberg Manufacturing Company, was devoted to the features of design, operating costs and earnings of the municipal diesel power-plant at Carthage, Mo. For over 30 years this city has owned its electric and water systems. Beginning with steam power, a change was made in 1921 to diesel engines, and by 1928 the plant contained two 1,250-hp. and one 750-hp. diesel-engine-driven generating units. For the past six years the average load, or capacity, factor has been 31.8 per cent. Domestic lighting rates are from 8 to 4c. per kilowatt-hour, electric range rates from 3.75 to 2.8, secondary service from 1.6 to 1c., and commercial power service from 1.5 to 0.9c.

Operating profit has increased from $62,117 in 1925, to $98,056 in 1930, and it is anticipated that 1931 will show a decided improvement, owing to concentration of operation in one plant. Building and equipment costs totaling $500,000 have been paid for in the last ten years out of earnings. This has been accomplished while rendering dependable service at rates lower than those prevailing in other towns of the vicinity and while supplying at a nominal charge current required by the city for pumping and public lighting.

Reasons given for the success of this plant are: a board of public works having the best interests of the city at heart, the absence of politics, excellent supervision, and the installation of engines of the heavy-duty slow-speed type, all of the same design and rated at 250 hp. per cylinder.

Advisability of installing engines of a design dating back ten years was questioned. Higher speeds permitted by improved materials would lower first cost of engine and generator, reduce the weight, and improve the utility of the engine to the customer. The author agreed that in weight and speed the engines at Carthage might be obsolete, but not in efficiency or maintenance. The latter has been particularly low, and the efficiency at least as good as in engines of recent design. The engine referred to weighs 300 lb. per brake horsepower, but designs were thrown on the screen that weighed 200, 175 and 130 lb., respectively. In the author's opinion, shorter life and more maintenance was the price of higher speed.

Heat Recovery from Internal-Combustion Engines

● With the internal-combustion engine about two-thirds of the heat in the fuel is wasted, one-third in the exhaust gases and another third in the cooling water circulated through cylinder jackets. Heat carried away in the water from the cylinder jackets necessarily is of a low order. Recovery of heat from the exhaust gases presents greater opportunities, although in some cases hot jacket water may be used as feed to supplement the heat recovered from the exhaust gases. A paper showing how a considerable portion of this waste heat may be recovered had been prepared by Thomas Clarkson, of London, and William Bradford, director of engineering of the Edge Moor Iron Company.

In the recovery of heat from the exhaust gases the authors laid down seven basic conditions, to which were added the avoidance of back pressure and the provision of an effective way of decarbonizing the heating surface. Thirty years of experience with boilers of many types which did not function effectively as mufflers or lend themselves to decarbonizing of the heating surface by "burning off," led to the evolution of the "thimble-tube" boiler, which in its primitive conception is an inversion of the porcupine boiler. This boiler or heater and its functioning were described in detail. A number of tables gave typical examples of heat-recovery tests with engines of both four- and two-stroke-cycle types. A chart of average efficiencies and temperatures of a four-stroke-cycle mechanical-injection diesel engine and waste-heat boiler indicated at full load an over-all engine and boiler efficiency of 57 per cent.

As the heaters on which tests had been reported in the paper had been changed recently to boilers, supplementary data sheets were presented in the discussion. In round figures the results obtained were 1 lb. of steam by weight

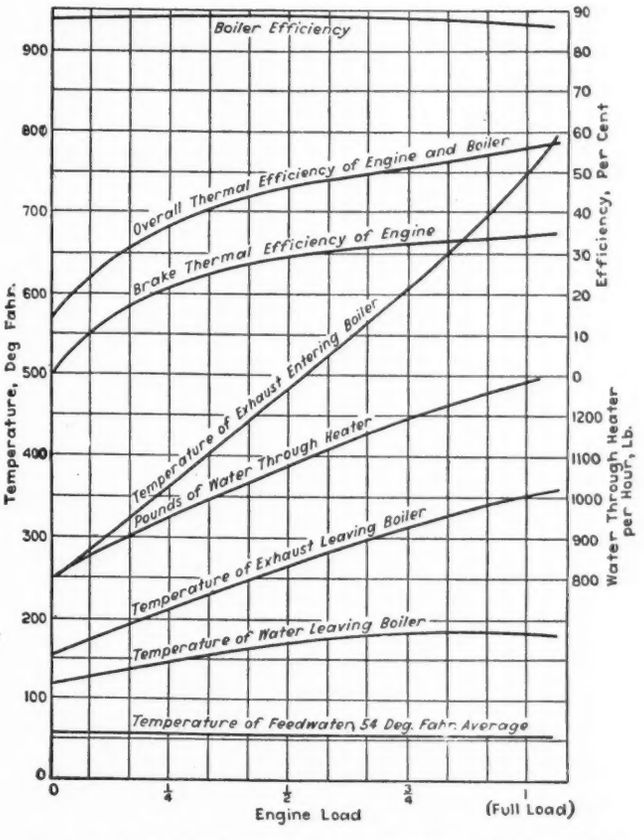

Boiler Efficiency
Overall Thermal Efficiency of Engine and Boiler
Brake Thermal Efficiency of Engine
Temperature of Exhaust Entering Boiler
Pounds of Water Through Heater
Temperature of Exhaust Leaving Boiler
Temperature of Water Leaving Boiler
Temperature of Feedwater, 54 Deg. Fahr. Average
Temperature, Deg. Fahr.
Efficiency, Per Cent
Water Through Heater per Hour, Lb.
Engine Load
(Full Load)

Chart of average efficiencies and temperatures of four-cycle mechanical injection diesel engine and Nelseco Clarkson waste-heat boiler

per brake horsepower-hour. With ordinarily good water and a dry pipe preceding the outlet, there has been little trouble from priming. Scaling in the tubes is prevented by the scouring action of the water rushing in to replace an accumulation of steam bubbles that have just escaped to the steam space. This pulsating action continues at all loads. In response to a question the author stated that the tubes do not offer appreciable resistance to the flow of the exhaust gases. In fact, in a test with and without the heater, or boiler, the same power was obtained with less fuel oil when the boiler was in service, as the latter functioned somewhat as a condenser.

Fairness and the service to American manufacturers and taxpayers warrant the full presentation of the Navy's attitude in the matter of purchasing foreign submarine diesels, since publicity has been given to the claim that American manufacturers cannot produce a serviceable unit

The Navy's Attitude Toward American Diesels

By L. H. MORRISON
Associate Editor, POWER

WHY American firms do not build submarine diesels to meet the Navy's requirements is asked by thousands after reading Congressman Britten's speech at the last session of Congress. As chairman of the House Committee on Naval Affairs, it was assumed that his statement that "the American diesel industry has fallen down and that not one had ever made any profit" was an echo of the opinion of the Navy Department. In an editorial in *Power* of Jan. 27, the opinion was expressed that the diesel industry has not fallen down and that the cited failure of Shipping Board diesels was no worse than early experience in more than one foreign motorship.

The Other Side Presented

● There are always two sides to any story, and while a technical publication adheres somewhat to the newspaper tradition of printing the news, it nevertheless has further a mission of consolidating ideas and detecting engineering trends.

With this in view the author spent some time in Washington, conversing with various naval officers and officials. In most cases the person interviewed expressed personal opinions which can not be quoted. This article, therefore, will not attempt to quote any man and should be taken as the impressions carried away by one who has had some experience in searching out others' thoughts and who has some acquaintance with the diesel engine and knows rather intimately the designing and manufacturing ability of most American diesel builders.

The present attitude of the Navy cannot be thoroughly understood without knowledge of the development that has gone on since the first United States submarine was launched.

Experience With Early Submarine Engines

● The early American submarines, built prior to 1912, were propelled by gasoline engines, as were the submarines of all European countries. In 1914 the New London Ship & Engine Company acquired a license from Vickers of England and built four four-cylinder, four-stroke-cycle diesels for the Submarine E1 and E2, which went into commission in 1912. The engines, as viewed from 1931 knowledge, were somewhat faulty in design. The cylinders were 12.75 in. bore and 13.5 in. stroke, but were without air-starting and were not reversible. To start the engine the generators were motorized, taking current from the battery. The designer had made a serious attempt to lighten the weight and so employed steel-plate columns or "A" frames to support the cylinders from the upper end, with the lower ends of the columns resting on the cross girder of the bedplates. The crankcase was inclosed by light sections. The cylinder liner was, to all purposes, the cylinder itself, since its upper flange was bolted to the cylinder head, and the water jacket was a light shrunk-on casing. All the working pressure was carried from the cylinder head through the plate columns to the bearing girder. To reduce the engine length the cylinders were spaced as closely as possible, and the between-cylinder head bolts served the two adjacent heads, the nut being arranged so as to seat on the two heads.

Six-cylinder engines of this design were installed on the F class of boats in 1912. The camshaft ran along the crankcase, with long push rods leading to the valve rocker arm. The valve cages had the connecting elbows integral, which permitted the use of a shallow cylinder head. Incidentally, this valve arrangement is much like the design on the modern English Fraser diesel.

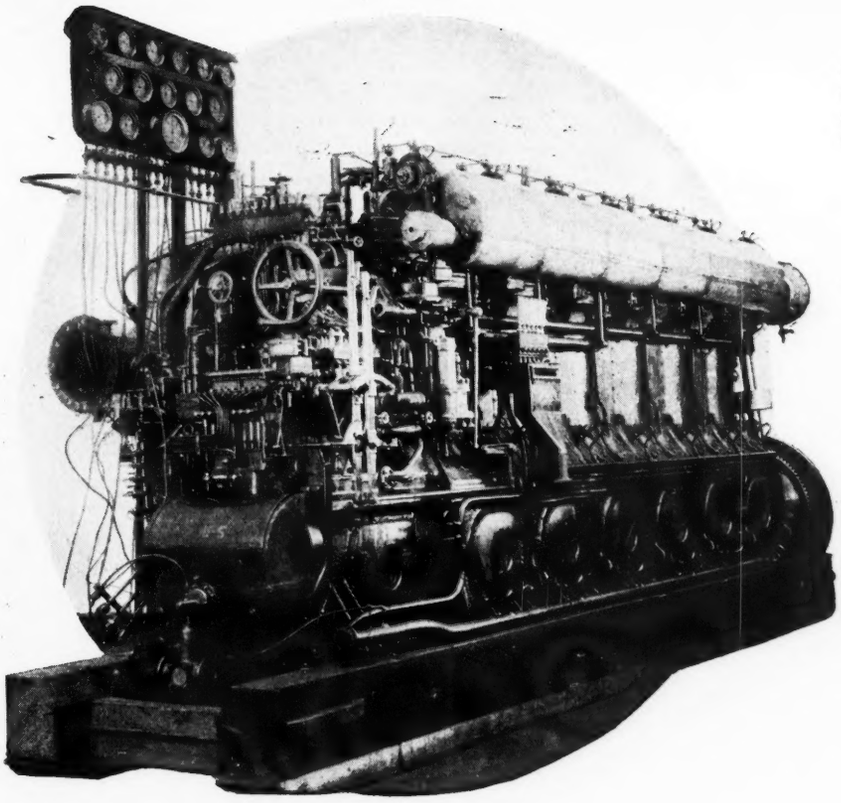


Fig. 1—Several of these 1,000-hp. diesels were built at the Brooklyn Navy Yard

Even a modern diesel engineer after examining the cross-section of one of these engines would find it difficult to predict where trouble would occur, for it was the little things that caused the design to be abandoned. The cylinder head bolts could not bear equally on both heads, so one joint would open and blow by. The water used in the water-cooled bearings leaked into the crankcase and damaged the lubricating oil—and it must be remembered that in 1912 the centrifuge oil separator had not come into use.

If the reader will appreciate the period, 1911-1912, and recall the scarcity of diesel information in engineering circles, it is not surprising that the operating force of that time found difficulty in keeping the engines in service, especially in the limited space of a submarine. Inspection was difficult and running repairs almost impossible because of conditions pertaining to the submarine service.

The Two-Cycle Engine Tried

● These engines were removed, and, as the hulls were still good, new units of a different design were installed. At this time, 1912, the two-stroke-cycle diesel seemed to offer a number of advantages. For given cylinder dimensions, the power was greater than that of the four-stroke-cycle. Its valve mechanism was simpler and its reversal easier, for the reverse gear was not complicated, involving no shifting of valve rollers from ahead to astern cams.

The M.A.N. Company of Augsburg had been one of the first to engage in diesel construction and by 1912 had developed, among other designs, a two-stroke-cycle submarine engine for the German Navy. The New London Ship & Engine Company, at the suggestion of the Navy Department, procured a license for the M.A.N. engine and built a number after that design for the H and K classes of submarines. The cylinders were 11 in. bore and 12.75 in. stroke and scavenging air was introduced through a valve in the head, which was cast as a unit with the cylinder. In an attempt to obtain maximum strength the crankcase and housing were made of vanadium bronze, as were also the lower bearing shells, with the shaft of nickel steel. In the light of today's knowledge this design would not be classed among the best, but for the period, 1913, it was equal to any in Europe.

Operating results from the several engines were not consistent. Some of the difficulties were traceable to the then high speed of 450 r.p.m. In addition the stepped piston encouraged the passage of the oil-laden crankcase air into the scavenging air pump, with the result that explosions were frequent.

The circulating water pumps were of the reciprocating type, direct connected to the engine. As there were no stand-by pumps, the least pump trouble threw the entire engine out of service. Incidentally, the reciprocating plunger pump was a fixture on marine engines long after the designer of stationary diesel plants had abandoned it in favor of the motor-driven centrifugal type.

The location of the pump was such that water leakage found its way into the piston oil cooling system. Salt water emulsion would not keep the piston crowns cool, and many fractured. The construction made it difficult to replace a piston. The entire cylinder camshaft, headers and pipe connections had to be removed to reach the piston, and it is not surprising that inspections were seldom made until the engine stopped from gas blow-by.

As nothing better in the way of engines was available, similar units, embodying several improvements, were installed during the war in the Class L submarines. Notable among these improvements was the employment of two instead of one scavenging valve in the cylinder head, and rotating pumps replaced the old reciprocating pumps, though still driven from the crankshaft.

Despite experience with the early engines, these modified ones were equipped with oil coolers of limited capacity, and the method of driving the water pumps soon wore the parts. In addition it was rumored that the sea valves on the exhaust outlets admitted sea water whenever the submarine submerged, and this water, it is claimed, wrecked many pistons and cylinders.

By this time the Navy and the engine factory began to realize more the importance of little things; that designs quite satisfactory as long as they remained in the draw-

ing room might not prove so in regular operation.

The engines for a new submarine were of the same general design but extensively modified. The cylinder head became a separate part, the stepped pistons were abandoned and the air was supplied by two double-acting blowing tubes placed at the forward end of the frame. Cross heads were added to all pistons, even though low height was essential. These engines were designed to operate at 350 r.p.m. and the six cylinders, 10.5 in. bore and 16 in. stroke, were rated at 420 horsepower.

While test floor results were satisfactory, as might be expected, the cylinder jackets, which were integral with the liners, cracked. The oil coolers were so small that the bearing and piston-cooling oil could not be held down to a reasonable temperature, and the design of the crankcase sump pan permitted oil to leak out into the hull. While the engines operated in a more or less satisfactory manner in 1918, at the end of the war the inexperienced crews placed aboard these submarines could not run the engines, so they were abandoned.

Swiss Engines Not Satisfactory

● At about the same time as these M.A.N. engines were being developed, two Sulzer Brothers diesels were imported and installed on the G3. Each engine had six cylinders of 12.6 in. bore and 12.6 in. stroke, the first "square" cylinders installed by the Navy. At 450 r.p.m. the units were rated at 600 hp. each. The two scavenging pumps of the double-acting type were arranged at the forward end of the crankcase; the injection air was given its initial compression in a cylinder formed by the crosshead of the scavenging pump, while the two succeeding stage of compression were obtained in a cylinder driven by a rocker arm from the scavenging pump rods. Water pumps of the reciprocating type were installed in spite of trouble with this arrangement in the older submarines. The bedplate was of cast bronze, while the cylinder heads were in one rigid assembly with tie-rod struts between the heads and the baseplate.

Although test results at the Swiss factory were excellent, the engines failed to fulfill expectations. The compressor drive was poorly lubricated and the oil and water pumps too flimsy in structure and not of sufficient capacity. This boat was soon found lacking in reliability.

As a result of the experience with the G3, when Busch-Sulzer built a 600-hp. 375-r.p.m. six-cylinder engine of the same design many details were altered. In addition Busch-Sulzer Bros. Diesel Eng. Co., St. Louis, built for the Navy a 400-r.p.m. 300-hp. engine with cylinders 9.5 in. bore and 12 in. stroke. This engine was not reversible and was started by motorizing the generator, but the 600-hp. unit had a reversing gear and was provided with air-starting. These American Busch-Sulzer engines were somewhat different from the Swiss engine on the G3 submarine. The cylinder head was cast in one piece with the cylinder, a practice followed on the high-speed stationary engine of this manufacturer. The cylinders were bolted together at the square section of the exhaust port belt and the tension rods reached from these blocks to below the frame cross members. Light "A" frames bolted to the baseplate supported the cylinder entablature, but the tension rods took all the working stresses. One interesting feature of the engine was the arrangement whereby the crankshaft could be rolled out on one side of the frame by removing the frames and the tie rods on that side. The fuel pumps were driven from a vertical shaft driven from the crankshaft, with the overspeed governor placed at the shaft's top.

Both the 300- and the 600-hp. units operated satisfactorily, despite some minor difficulties such as the indifference of the pump drive, breakage of the compressor valves and inferior oil coolers. Nevertheless for their day their performance was fully up to contemporaneous European diesels.

Revert to Four-Cycle Type

● Navy officials, however, displayed a preference for four-stroke-cycle engines, and several different sized engines were developed by the New London Ship & Engine Company. All had the horizontal valves and long rockers typical of that company's design. These engines ranged in capacity from 120 to 440 hp. All had bronze crankcases, but it proved difficult to obtain bronze castings of uniform thickness and strength. Originally the working stresses were taken up by the case walls, but later tie rods were added. These engines were in service from 1918 until recently, when they were sold to a contractor who rebuilt them for stationary service.

The next engine built by Busch-Sulzer, of St. Louis, for the navy was a 500-hp., 400-r.p.m. four-stroke-cycle diesel with six cylinders of 14.25 in. bore and 14.5 in. stroke. These did not differ greatly from the earlier Busch-Sulzer submarine engines, save, of course, in the cylinder design. The bedplate was of bronze, to which the Navy still adhered. Cylinder heads, with water-cooled exhaust valve cages, such as employed on stationary diesels, were used, the camshaft and valve gear also followed standard practice. Three sets of these engines were installed upon the "O," "R" and "S" type submarines.

Minor difficulties appeared, most of which were due to space limitations in the vessels and the indifferent care given the machines by the operators, who too often were inexperienced. Trouble that developed with the fuel pumps was attributed to poor operators, for the design has been used with success on many stationary engines. The vertical drive shaft, from which the fuel pumps were driven, operated at engine speed, and the fuel charge to each working cylinder was made up of two fuel pump deliveries. As a consequence, fuel was delivered to some of the cylinder spray valves during the cylinder's exhaust strokes. If the spray valve leaked the fuel would cause a smoky exhaust. Lack of operating skill rather than engine design seemed to be responsible for this trouble, for no spray valve should be allowed to leak; and a leak during the compression stroke is more dangerous than on the exhaust stroke. In spite of minor troubles one boat equipped with these engines made a trip across the Pacific and back.

Other four-stroke-cycle engines contracted for during the war were eight-cylinder New London four-stroke-cycle units of 13.5 in. bore and 15 in. stroke, rated at 600 hp. at 380 r.p.m., and Busch-Sulzer 900 hp. two-stroke-cycle engines of $14\frac{7}{8}$ and $16\frac{3}{8}$ in. stroke.

The eight-cylinder New London four-stroke-cycle units were provided with cast-iron crankcases and bedplates, the Navy having decided that bronze castings were not suitable. During the final months of the war many of these engines were built, the manufacturers subcontracting for many of the parts. Torsional vibra-

tions occurred, and the engine speeds were dropped to bring the shaft out of the critical zone. Various attempts were made to place dampeners on the engines, three different types receiving attention, but none stood up in service.

Still another diesel development was a double unit, consisting of two six-cylinder New London four-stroke-cycle, six-cylinder, 18 in. bore and 19 in. stroke engines coupled together in line. The combination was rated at 1,000 b.hp. at 375 r.p.m. With present-day knowledge, it is obvious that this combination would give trouble. The shaft length induced severe torsional vibration. Experiences with these boats led to the adoption of electric drive for engines placed forward, while the off engines drove the propeller shaft directly.

Other engines developed, prior to or during the war for the submarine service were a Busch-Sulzer two-stroke-cycle, a four-stroke-cycle McIntosh & Seymour 250-hp., eight-cylinder unit, and a six-cylinder, four-stroke-cycle Craig diesel.

Lessons from Foreign Practice

● After the war the Navy Department obtained several German submarine diesels, and as a result of a study of these engines evolved the Bureau type of diesel, several of which were built at the Brooklyn Navy Yard. One of these 1,000-hp. units appears in Fig. 1. While the engines are concededly of light weight, there are several details upon which engineers may not agree. The reciprocating pumps are inherently unsuited for engines, and more modern types should be adopted, so some claim.

The Navy obtained from the British Government two 2,500-hp., 345-r.p.m., 10-cylinder M.A.N. engines originally intended for German submarines. Outstanding points on these engines are the steel castings, which are free from flaws. When the Navy started to build from M.A.N. designs at the Brooklyn Navy Yard difficulty was had in obtaining suitable steel castings from commercial foundries, and the Yard proceeded to cast its own frames. There was some question as to the quality of these castings, since there was a tendency to overlook minor defects and so reduce costs.

Still another large diesel built for the Navy was the 2,500-hp. Busch-Sulzer, two-cycle, 325-r.p.m. unit shown in Fig. 2. This was provided with crossheads, and the cast-iron piston had cast-steel, oil-cooled piston crowns. The framing was of cast iron. In sea service the cast-steel piston crowns failed to meet expectations and were replaced by forged-steel crowns. These were, in fact, blocks of machined steel. The cast-iron frame received the cylinder reaction, cracks appeared along the frame above the crankcase doors, due doubtless to the concentration of the stress on one or two of the bolts. To eliminate this the frame was provided with reinforcement at this weak section. Other difficulties included some fractured heads and compressor valve trouble.

In 1930 the Navy sent an officer to Europe, who, after visiting all the important factories, felt that the M.A.N. firm offered the highest developed design, consequently the Navy Department purchased a 600-hp. M.A.N. 750-r.p.m. submarine engine, which was received in May, 1931. Early in 1931 domestic diesel manufacturers were invited to submit bids on a 600-hp. diesel to conform to broad specifications laid down by the Navy.

Basically the bidder was to offer a four-stroke-cycle six-cylinder mechanical-injection engine of not less than 100 hp. per cylinder at a speed of 700 r.p.m., the cylinder bore to be approximately 11 in. and the stroke 15 in. The weight was not to exceed 22 lb. per horsepower, the length 7 ft. 9 in., width 5 ft. and the height not over 6 ft. 6 in. These dimensions conform to those of the purchased M.A.N. diesel. Somewhat strangely, the Navy will permit no aluminum alloy in stress members. On the other hand, the liberality in cylinder liner permits a wear of 0.005 in. per 1,000 running hours.

At the time this is written, but one American engine builder has indicated an intention of bidding. The Electric Boat Company (formerly New London Ship & Engine Company) has obtained a M.A.N. license for submarine engines. This engine has the same design of fuel pump and open-type spray valve as that employed on the slower-speed M.A.N. engines now being built by the Electric Boat Company.

In addition to the 600-hp. imported diesel, the Navy Department plans to purchase a 2,500-hp. diesel from M.A.N. This item was included in the Navy budget, and it was during the discussion of this item that Congressman Britton created a sensation by stating, on the floor of Congress, that American diesel builders had fallen down on the job, that none has ever made any profit, and that none could build an engine suitable for submarines.

Any controversey always has two sides, and seldom are all the good arguments on one side. To obtain light upon the Navy's attitude, the writer has discussed the subject with a number of naval officers. Most of these officers view the matter calmy; others, unfortunately, resent any disagreement with their views, taking the attitude that their patriotism is being questioned. In general, the Navy's experience with diesel engines up to the present time has not been satisfactory, with the exception of the German M.A.N. engines obtained after the war. It must be remembered, however, that other than the 2,500-hp. Busch-Sulzer engine already mentioned, all Navy diesels have been built after old designs. These designs were the best available in their time, but since 1917 the advances in diesel engineering have been greater than the developments in other types of prime movers. It is, so the writer feels, wholly unfair to resurrect these old engines and cite them as exhibits to prove the inferiority of American engines.

American Designers Do Not Appreciate Submarine Requirements

● Designers in this country, so the Navy feels, are immature in their engineering thinking. They fail to appreciate the significant difference between an engine mounted on a massive concrete foundation and one placed on the light, semi-flexible scantling of a submarine. These designers do not appreciate the possibilities of light weight steel parts and so far have been unable to design the cylinder head and liner to transmit sufficient heat to prevent excessive temperature stresses. These piston crown designs are too inferior to be placed where continuity of service is a vital necessity.

It is of little advantage for an American firm to obtain an approved European license for domestic manufacture, as unless altered they cannot be adapted to construction in this country. It is apparently the Navy opinion that American foundries are too committed to the mass-production, or tonnage, theory to have the patience needed to

cast correct diesel parts; it is impossible to obtain from any American foundry thin steel casting without flaws; only at an exorbitant expense is it possible for these foundries to deliver acceptable castings. For these reasons the Brooklyn Navy Yard has done its own casting, although it might be well to interpose at this point, that the Yard castings are by no means always high grade, and some are accepted that if shipped outside would probably be rejected.

The Navy claims that it has been extremely fair to American builders. Firms now building medium- and light-weight engines, that is, engines weighing less than 100 lb. per horsepower, have been encouraged for submarine service.

Light weight is more essential now than formerly. The restricted submarine tonnage permitted under the naval limitation compact requires that this tonnage be made up of as many light submarines as possible. To get surface speed the greatest possible horsepower must be obtained at the minimum of weight, for which reason the upper limit is set at 22 lb. per horsepower. Also it is desirable that the submarine be always in condition. The engines, the heart of the boat, must be reliable and free as possible from overhauling requirements.

Until American firms appreciate the pecularities of submarine service and design engines to meet these, the Navy officials feel that engines must be built at the Navy Yard. As it has no design of its own, the intention is to purchase the latest engine built by M.A.N. in Germany, which the Navy feels is the best European design. Duplicates of this engine will be built by the Navy.

American Builders Missing Opportunity

● But, so high Navy officials feel, American engine builders are missing an opportunity if they do not develop an approved submarine diesel. Electrification of the railroads is proceeding actively, but the employment of electrical locomotives is economical only on main lines with dense traffic, of which the mileage is quite limited, popular opinion to the contrary notwithstanding. The next great transportation advance will be dieselization of main lines of ordinary traffic density. The 300- and 600-hp. diesels available at present are suited only for switching service or rail cars. For main-line operations engines of 2,500 hp. must be used.

For these locomotive diesels the requirements are light weight, high speed, accessibility and reliability. Submarine diesels must have identical characteristics. While there will never be a demand for many submarine engines, nevertheless the American manufacturer who accepts the Navy's invitation to develop a submarine engine will be in a commanding position to meet the future demand for locomotive diesels. In the meantime the government cannot postpone submarine construction until this American engine has been developed.

More Cooperation Among Builders Needed

● In spite of the existence of an association of diesel manufacturers, Navy officials feel that there is too little cooperation among engine builders. The suggestion is made that several firms should form a common design and research departments with a view to the evolution of an engine design which could then be built by all the contributing firms.

Much of the trouble experienced is traceable to operating personnel. Unlike a commercial plant, the man responsible for the engine room is seldom an experienced diesel engineer. His assignment is too short to permit the accumulation of much beyond a theoretical knowledge of the machinery. Dependence must be placed upon the enlisted force, which many believe is by no means equal in technique and practical mechanical skill to the engine room force of a German submarine. Americans, as a class, are optimists, and the initial evidence of trouble, which would cause a German engineer to stop the engine for adjustments, is not viewed in the same light by the American. Engines in need of minor adjustments are sometimes kept in service until serious breakdown occurs.

A typical example ilustrates the American viewpoint. An engine was rated to develop, let us say, 600 hp. at 400 r.p.m. This the engine would do easily, with a brake effective pressure of probably 70 lb. Installed in a submarine with a propeller of known characteristics, the engine on its trial run was able to turn the propeller at 400 r.p.m. without exceeding the rated 70 lb. m.e.p. But after a time the submarine's plates collected barnacles and to turn the propeller at its old speed the engine became overloaded. Finally, this situation was appreciated, and at present the engines are run at a speed depending upon the condition of the hull, holding the m.e.p. down to the proper value. Since then cracked heads and pistons have become less prevalent.

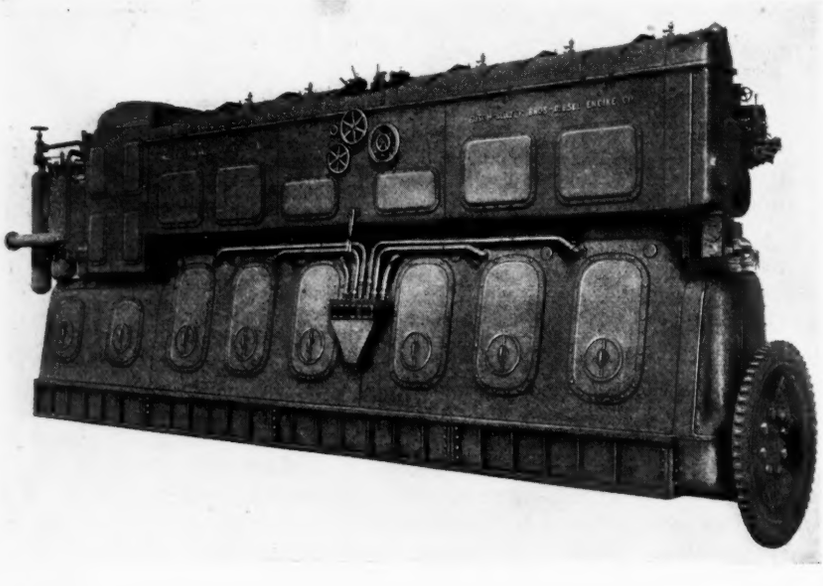
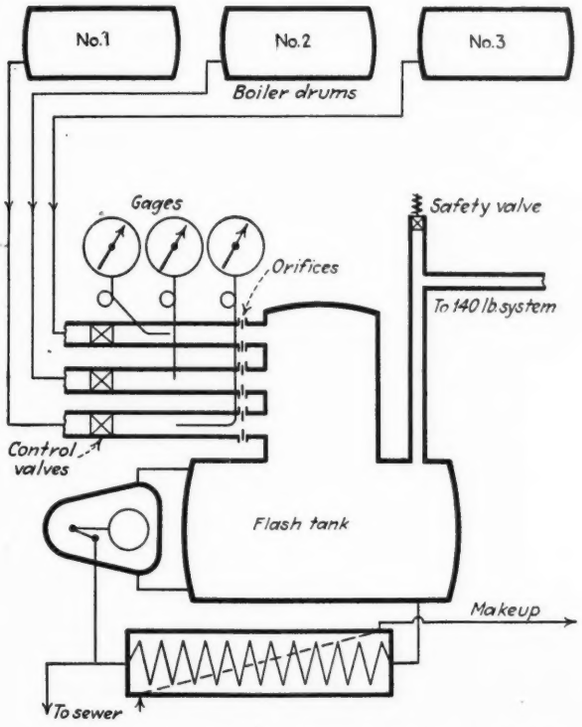


Fig. 2—One of the 2,500-hp. Busch-Sulzer diesels

Continuous Blowdown at Anheuser-Busch, Inc.

By A. B. STICKNEY
Fred Ophuls & Associates

THE continuous blowdown system installed in the new Anheuser-Busch power plant (St. Louis) which was described in the June 17, 1930, number of *Power*, contains two points which should be of interest to *Power* readers. The first is a cheap and simple meter for measuring flow; the second a nearly "foolproof" rapid method of determining concentration. Since, in this plant, the blowdown sometimes amounts to as much as 10 per cent of the feed water, its proper control is of the utmost importance.



Blowdown rate determined by gage readings and adjusted to maintain boiler-water concentration of 150 to 170 grains per gallon

The diagrammatic sketch shows the piping hook-up of the blowdown system. Briefly, blowdown passes from each boiler drum through a separate line to a flash tank in the water bay. At the flash tank is a control valve and an orifice, between which is a pressure gage. Since the flash tank is connected to a system pressure below the boiler pressure, in this case 140 lb., the low-side orifice pressure is fixed, and the high-side pressure gives a measure of flow. The orifice is small enough to give a pressure drop of about 20 lb. with normal flow. Observing these pressures at frequent intervals, the water-bay attendant keeps the control valves adjusted to give the desired pressures, and thus maintains the desired blowdown.

For the rapid method of determining concentration it is customary to multiply a silver-nitrate titration for chlorides by a factor which is redetermined by evaporation in the laboratory at frequent intervals. Since this factor varies frequently, it leads to errors by the boiler house attendants, if they determine total solids.

The method adopted at Anheuser-Busch is for the laboratory to maintain a silver-nitrate solution in the boiler house the concentration of which is varied with the solids factor so as to give a direct reading in grains per gallon of total solids. With this solution, accurate titrations may be made every four hours by the boiler house attendants themselves. Based on these, the individual blowdown control pressures are readjusted to maintain the desired concentrations, in this case 150 to 170 grains per gallon.

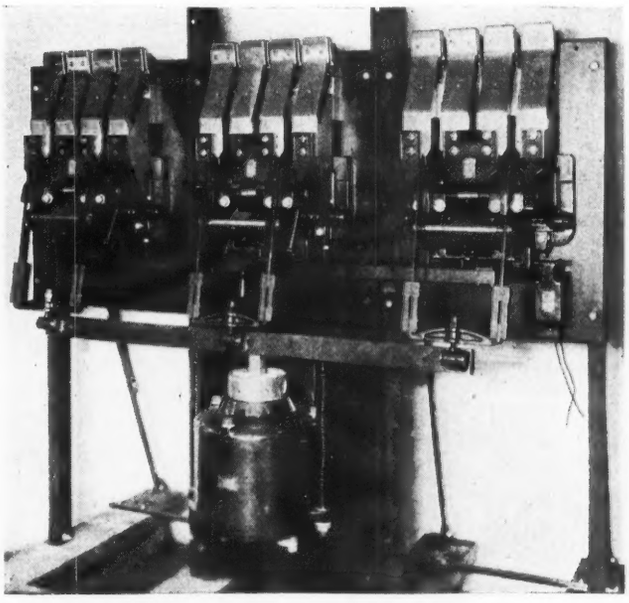
▼

Carbon Circuit Breaker Has Normal Rating of 48,000 Amp.

ONE OF THE largest carbon circuit breakers ever made was produced recently by the Westinghouse Electric & Manufacturing Company. The circuit breaker is solenoid-operated, the core of the latter being 7 in. in diameter and capable of exerting a force of over 3½ tons direct pull. The solenoid mechanism, including the coil, weighs approximately 500 lb. and the coil alone nearly 200.

The breaker is made up in three sections, each one of which has a direct-current continuous carrying capacity of 16,000 amp. With all sections operating in parallel, the breaker has an approximate direct-current rating of 48,000 amperes.

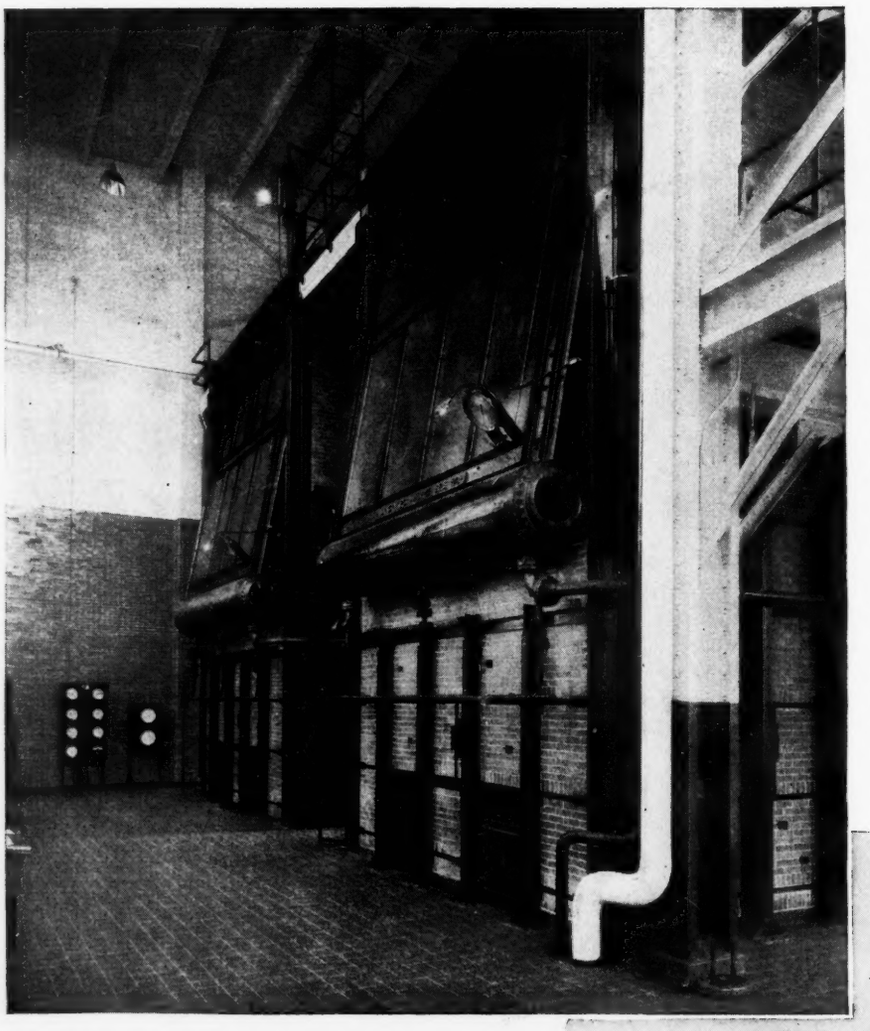
To close an air circuit breaker of this size the forces involved can best be obtained by considering those necessary to compress the main moving brush contact. In this breaker there are four brushes per section, each requiring in the neighborhood of 1,000 lb. to compress it. The total compressive force required when applied directly to the backs of the twelve brushes exceeds 6 tons. The breaker has an interrupting capacity of 105,000 amp. per section at 600 volts.



This breaker will interrupt 315,000 amp. at 600 volts

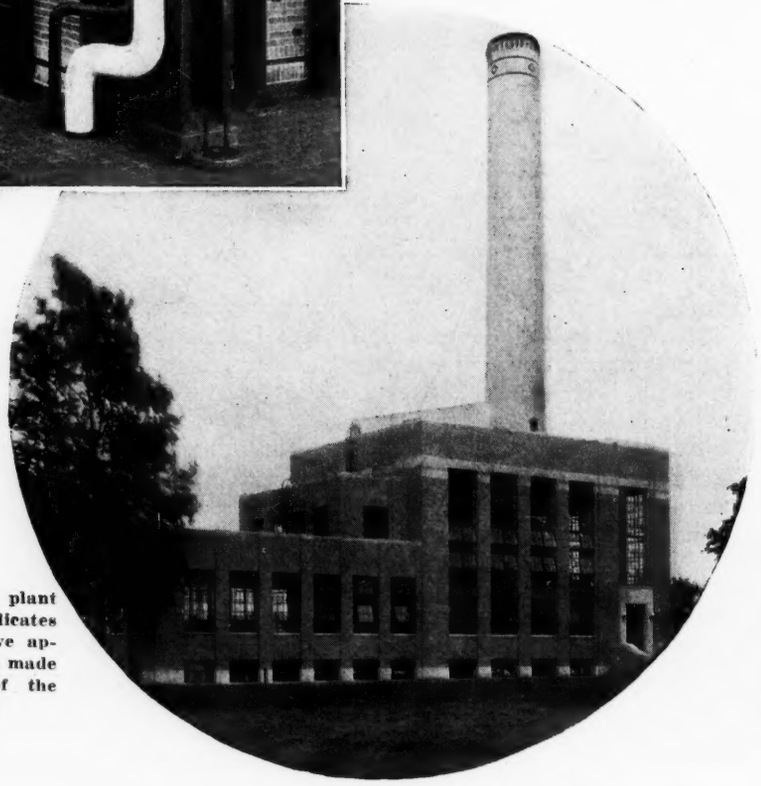
PUBLIC LIBRARY
DETROIT MICH.

SERVICING AIRCRAFT



Two oil-fired boilers supply saturated steam at 165 lb. pressure

AT HARTFORD, CONN., a power plant has been erected to supply jointly the Pratt & Whitney Aircraft Corporation and the Chance Vought Company with steam, hot water and compressed air for process work and hot-water heat for the buildings. Electrical energy is purchased. These two industrials are spaced 500 ft. apart. The location of the power plant is midway between them, and, contrary to common practice, to the front of the property. This was necessitated by the fact that the entire rear of both plants is used as proving grounds for airplanes and motors, and also as an airport, some 2,000 acres of land having been secured for this purpose. A stack, water tower, or any other type of vertical construction on the airport would be a flying hazard. Owing to the conspicuous location, special pains were taken to make the building and the arrangement of the equipment attractive, and the personnel takes pride in keeping the plant clean and ready for visitors.



The power plant exterior indicates that attractive appearance was made a feature of the design

PRODUCTION

Distribution of the services is through reinforced concrete tunnels entirely underground and provided with hatches to facilitate access. The tunnels are, respectively, 400 and 860 ft. long.

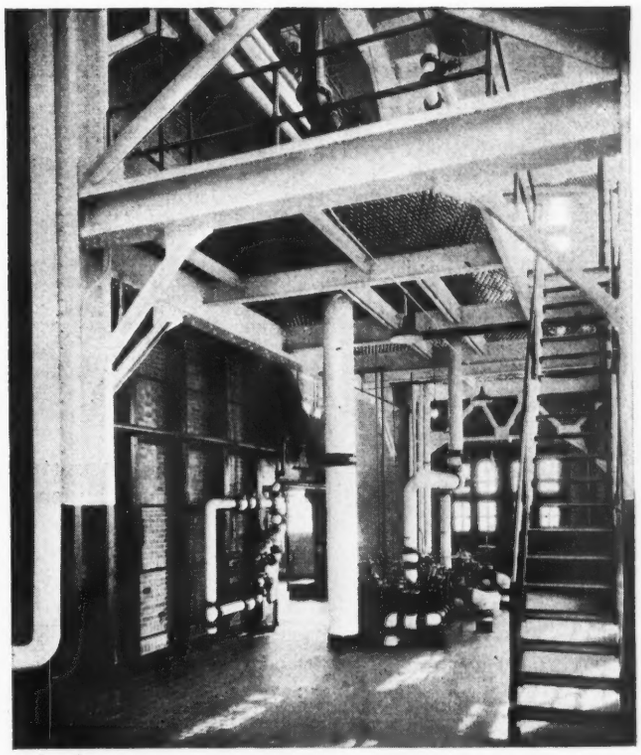
As the manufacture of aircraft and aircraft parts gives unusual promise for future expansion, provisions were made in the locations of buildings and equipment and in the sizing of the piping systems for capacities doubling present requirements.

In the boiler room present demands call for two 7,500 sq.ft. bent-tube boilers supplying dry saturated steam at 165 lb. pressure. These boilers with their furnaces are above the first floor, leaving the basement free for the auxiliaries, ducts and much of the piping. Supported, hollow, air-cooled walls with natural ventilation surround furnaces of 3,000 cu.ft. volume.

For cleanliness and convenience of control, oil was selected as the fuel. Six burners equipped for mechanical atomization are fitted to each furnace. The fuel oil is stored in six underground tanks heading into a working tunnel housing the fill box piping system and the pumps. Oil and steam lines are carried in underground conduits to the power house. Physical conditions for proper atomization of the oil are: temperature, 260 deg.; pressure, 125 pounds.

Two turbine-driven forced-draft fans of 32,000 c.f.m. capacity each at $2\frac{3}{4}$ in. static pressure supply air for combustion. Gases are drawn from the boilers by a reinforced concrete stack 12 ft. in diameter rising 140 ft. above the burners.

Two 225-g.p.m. centrifugal pumps driven by steam turbines draw from an open feed-water heater which receives the condensate returns, or make-up water under float control, and exhaust steam from the auxiliaries.



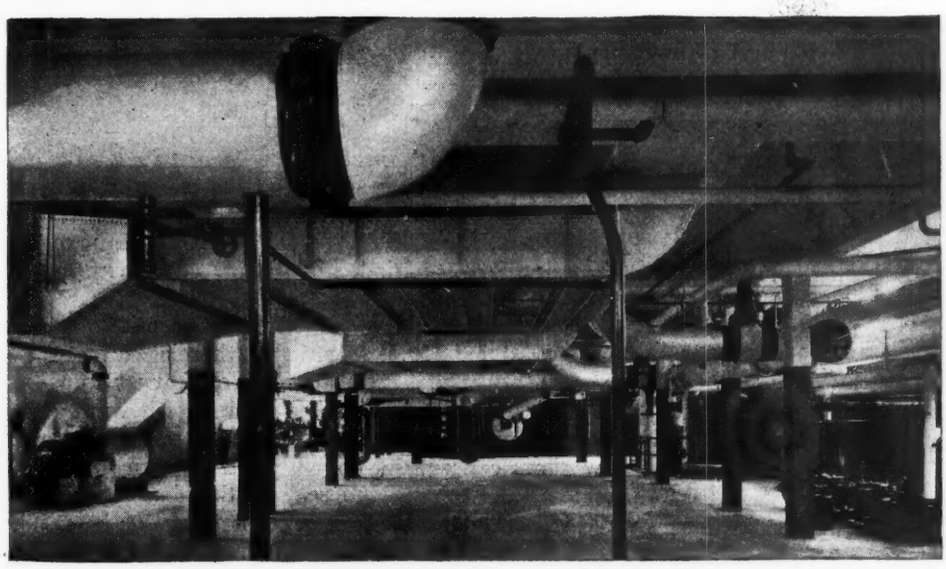
Turbine-driven boiler-feed pumps on main floor, and (above) the heater platform

Distances involved and the desire for uniform temperatures dictated a hot-water heating system under forced circulation. The equipment consists of two instantaneous, closed, vertical heaters, and a 4,000-g.p.m. turbine-driven pump. Under maximum conditions a temperature differential of $200 - 170 = 30$ deg. is maintained between the outgoing and the return water. Outdoor temperatures referred to a chart give the proper temperature in the heating supply to maintain the temperature desired throughout the plants. Exhaust steam from the auxiliaries is supplemented in severe weather with live steam reduced to 3 lb. pressure.

In the machine room on the first floor, containing the heating equipment, two duplex two-stage air compressors with intercoolers are each capable of supplying 500 cu.ft. of air per minute. One of these machines is motor-driven.

A complete system of fire protection, including fire lines, yard hydrants and automatic sprinkler systems in the buildings, has been provided. Fire lines are supplied by a 150,000-gal. gravity, overhead tank and two 1,000-g.p.m. pumps with two city-water connections. Alternate sources of power for pump driving also are available, as the drive in one case is a motor, and in the other a steam turbine.

The power house, the factory buildings of both companies and the interconnecting tunnel system were designed and the erection supervised by Albert Kahn, Inc., of Detroit.



Basement view, showing neat arrangement of piping and air ducts

. . . RIGHT OUT OF THE PLANT . . .

Diesel Piston Trouble Solved by Rearranged Cooling System

OUR plant was put in service about Aug. 1, 1925, everything being entirely new. We have two 130 hp., solid injection diesels, each engine being in service approximately half of the time, in relays of half a month.

The arrangement for the discharge of the cylinder-jacket water was as shown in Fig. 1. It will be noted that the water from both cylinders combines in the 2-in. header; so the operator could not learn what proportion of the water each individual cylinder was passing. We did know that, at times, the temperature at the funnel outlet was quite high and that the thermometer registered around 180 deg. F. under heavy load. Under these conditions there would be a pound in one of the cylinders.

After nearly two years of service the pistons began to burn through at the heads and pass exhaust gases into the crankcase. New pistons were ordered for both engines. The new pistons lasted about six months, and had to be bored out at the head and plugged to keep them in service. A well-equipped local machine shop was then intrusted with the job of making another set of pistons, which were installed Nov. 1, 1928. About this time the 2-in headers shown in Fig. 1 became so badly corroded that new ones were necessary. Examination of the outlet in the exhaust header behind the flanges showed an opening of $1\frac{3}{4}$-in. diameter. After some study it was decided to give each cylinder an independent discharge of $1\frac{1}{2}$-in. pipe to the funnel. At first no valves were put in these pipes, but it was found that one cylinder would tend to take all the water, leaving the other cylinder with too little; so the valves were put in to correct this. These changes were finished in June, 1929, and from October, 1928, until that time, several of the pistons with the plugged heads had been used, taken out and replugged.

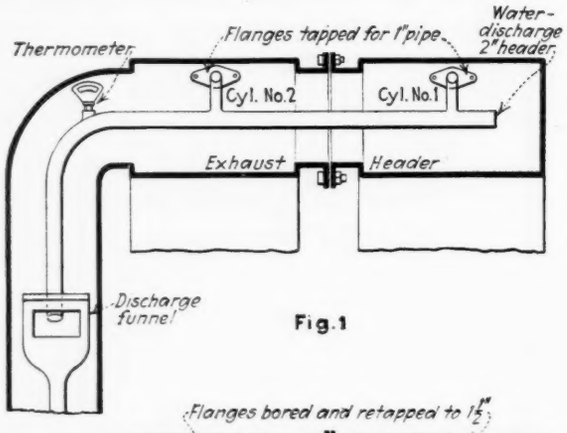


Fig. 1

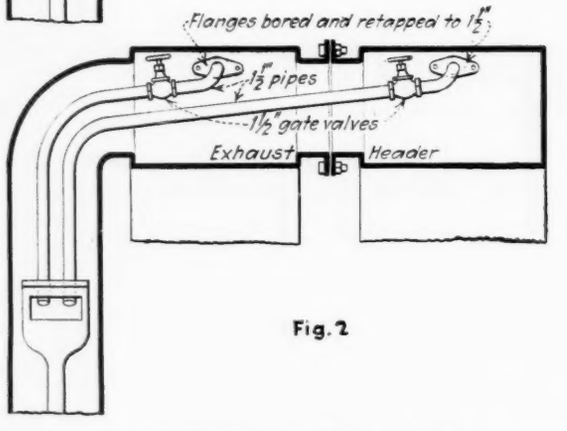


Fig. 2

Fig. 1—Original cooling water header

Fig. 2—The header after alterations

It was unnecessary to replace the thermometer, because the quantity passing per cylinder being greater, the increase in temperature was much less. The quantity of water passing through the $1\frac{1}{2}$-in. pipes is maintained at the least amount that will run a full pipe. Corrosion in the pipes, due to the dissolved oxygen, has been reduced since the reduction of temperature of the jacket water. Since June, 1929, we have not changed a piston, and have run six months at a time without taking one out for cleaning.

We may be wrong in crediting the big improvement in the engine performance to this simple change of piping, but the improvement followed immediately on the change. The present pistons, when taken out for cleaning, show a nice polish on the heads and are still in excellent condition.

THOS. C. HULTON.

Abras Grandes, Prov. de Camaguey, Cuba.

Employee Advancement by Stepped Wages or Stepped Jobs

ONE OF THE great disadvantages associated with the incentive plans of wage payment, as suggested by the article entitled "Employee Advancement by Stepped Wages or Stepped Jobs," in the April 28 number, lies in the stimulation of individual effort at the expense of cooperative teamwork.

Although the results obtained from incentive systems, as suggested, have been remarkable, there are at the same time some advantages which occur from having a number of workers concentrate cooperatively on the work to be done as a whole and some disadvantages when a number of workers concentrate only upon their own individual production. Each worker realizes that he is paid only for what he produces, and it is but natural that he should strive to increase his own output, regardless of all else, for the reward of a better job or more money. As competition is often keen, a worker feels that he has no

time to help out a new man or give a fellow worker a hand when he is in difficulty; also he is unwilling to lose time doing a little extra work which he feels will handicap him but will speed up the shop output as a whole or help out the supervisory force. Lack of cooperation between the men and the management and among the men themselves is common, unless some plan of wage payment is chosen whereby the men will be paid for the little extra work they are capable of performing but which is not itemized on the job ticket.

Various manufacturing requirements render a choice of incentive wage payment plan difficult, but in most all cases the goal worth while achieving is cooperative teamwork instead of individual effort. For example, a man milling a casting to be drilled will try harder to remove all burrs so that the piece will fit the drill jig of the next man smoothly, when all men are paid on the gang or group or shop output. If any burrs must be filed off he will do it while the machine is making the next cut. The drill press operator, with this cooperation, can work steadily and perhaps help in some way to make the assembly of the drilled casting easier. If an operator is forced to stop his own work for any reason he will aid in some other operation, for he knows that he is helping himself when he cooperates to the fullent extent, and he is also making the working environment of the shop more pleasant. Such things, although small in themselves, mount up in the aggregate, production is speeded up and close cooperation between the management and the men and among the men themselves is not lacking.

When this teamwork is practiced where possible and an adequate system of promotion provided for initiative and self-reliance it creates an equality among the workmen that is impossible under individual systems, as competition is eliminated and friendly feeling is substituted.

Brooklyn, N. Y. WILLIAM ANDERSON,
Pipe Shop Foreman,
E. W. Bliss Company.

Temporary Valve Repairs Prove Permanent

AN AUTOMATIC VALVE in which the seat ring and valve guide are in one piece broke and no replacement part was immediately available. As the valve was urgently needed, a repair was made, as shown in Fig. 1, by drilling and tapping the bottom plate to take a standard nipple of the required size. Although a new part was purchased it was not used; the "temporary" repair has been in service for four years.

In Fig. 2 is shown a monel-trimmed oil relief valve in a pumping system that became honeycombed and useless when the system was used for hot tar. Cast-iron parts had to be made special, which, of course, required time. So the seat was faced off flat, as shown in the sketch, and the valve trimmed down for the addition of an iron plate

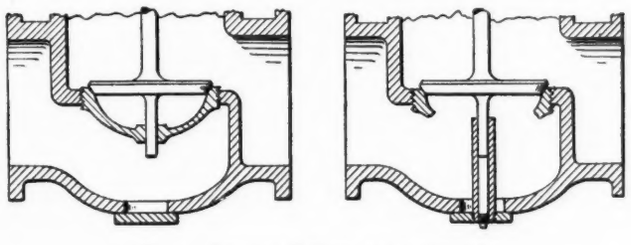


Fig. 1—Improved guide for valve disk

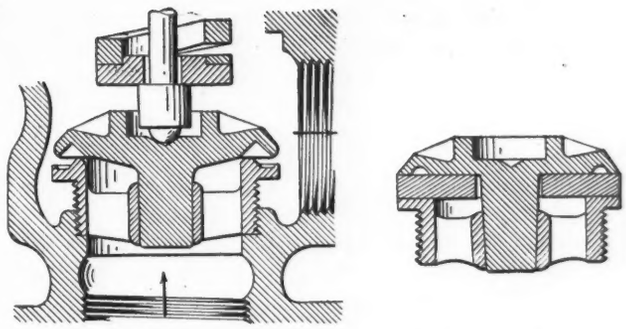


Fig. 2—Valve before and after repairs were made

drilled to fit over the guide. This was, of course, quicker to make than an entire new part. The repaired valve was in service again in an hour. The emergency parts have never been replaced, as the valve works perfectly.

Madison, N. J. B. F. POWELL.

Conveniences in the Power Plant Make for Efficiency

POWER PLANT APPLIANCES that take the drudgery out of otherwise toilsome details of operation are a source of profit to the owner as well as a balm to the man in charge, for, by the saving of time and effort they effect, they enlarge the worker's opportunities for bestowing thorough attention upon every detail of operation. Where, for example, the one-man crew of a small boiler and engine plant must depend upon the laborious methods in vogue fifty years ago for keeping his one or two boilers free from soot, he is apt to approach his further tasks with diminished zeal after he has completed his daily round of tube cleaning. Not so if the management has furnished him with the convenience of a modern system of soot removal—an apparatus that will insure a thorough job in comparatively brief time without the expenditure of excessive labor.

The advantage of automatic operation wherever practicable is clearly apparent. Besides saving time and effort it makes for accuracy. It is generally agreed that nothing definite can be known regarding the economy of a boiler furnace without an analysis of the combustion gases. With a portable Orsat apparatus the engineer can "keep tabs" on the performances of his boiler furnaces—after a fashion. But he gets only a desultory, and therefore unsatisfactory, record of what is going on. With a set of combustion recorders, which give the analyses automatically at short intervals throughout the whole period of operation, he has his work of furnace observation reduced to a perfect system. The work is performed much more satisfactorily and the drain on the engineer's time and attention is removed.

The economy of steam generation is improved by keeping the water in the boiler at a constant level, or at a definitely varying level consistent with the character of load the boiler is carrying. If the fireman must be continually adjusting by hand the speed of the feed pump, the water level may often be out of sight at either end of the gage glass. But with the convenience of a set of automatic feed-water regulators, in perfect condition, hand adjustment of the pump throttle is one task that is removed from the fireman's list of duties. In the one case the operation is attended with waste and uncer-

tainty; in the other economy is conserved and the job is made easier for the fireman.

In summer weather the atmosphere men must breathe in engine and boiler rooms, located in basements, often is enervating in the extreme. In practically every instance it is possible to improve this condition by installing the needed conveniences. And the things needed may not alone be conveniences for making the job less onerous; they may also be essentials in a money-saving sense that will operate to cut down expenses. A more liberal use of heat-insulating material, for example, will reduce the room temperature many degrees and keep a lot of heat units from going to waste. It is always possible to supply a liberal quantity of fresh air from outside into underground engine and boiler rooms. Apparatus also can be installed for drawing the heated air from the top of the room and delivering it to the furnace ashpits. But often it is hard for the engineer sweltering in the stifling atmosphere of one of these subterranean power plants to bring his employer to his own point of view in these matters.

Many engineers are loaded down with petty responsibilities. These consume time that might better be spent in studying more important problems. Much of this time-absorbing attention to details can be avoided by taking full advantage of the conveniences which engineering invention has made available. Any appliance that curtails the demand upon the operating man's attention in one direction gives him freer opportunity to attend to matters of perhaps more vital importance.

St. Louis, Mo. D. J. ALTIZER.

"Why Air Agitation in Ice Cans?"

REFERRING to the article under the above title which appeared in the March 17 number of *Power:* It is evident that the person who wrote the editorial in *Power* has not studied manufactured ice from a sanitary standpoint. He has failed to state that natural ice has been condemned in many cities and towns. Proprietors of public institutions are forbidden to use natural ice in glasses of water, and in dishes which are touched by food products. If he were familiar with the general conditions in manufacturing commercial ice from raw water, he would realize that raw water often contains considerable matter in suspension as well as matter in solution, and when concentrated in the core or center of the ice block it is extremely polluted, making that portion of the ice block decidedly unsanitary.

Furthermore the men who take care of the fillers frequently carry filth on their shoes. When walking over the tank this filth finds its way into the ice cans. The use of raw-water air agitation eliminates this solution and filth. All impurities that find their way into the ice can are held in suspension until the cores are pumped.

Regarding domestic refrigerators. They are capable of making small ice cubes which are cloudy, but that argument should not be used as an excuse for cloudy ice. It has been proved that odors and impurities get into the water after leaving the filtration plant of the city waterworks and are frozen into these small cubes, which are often decidedly unsanitary as a result.

The editorial also makes the statement that the household refrigerator machine manufacturers have completed their educational work regarding the sanitation of these small white ice cubes. I disagree with him, for the reason that large ice manufacturers throughout the country are now making small ice cubes which are perfectly pure and clear and are selling them at a very nominal price. They are becoming more progressive as time goes on in bringing to the public's attention the unsanitary ice cubes made in household refrigerators and are proving to users that the ice cubes produced by large ice plants are far superior and more pleasing to the consumers.

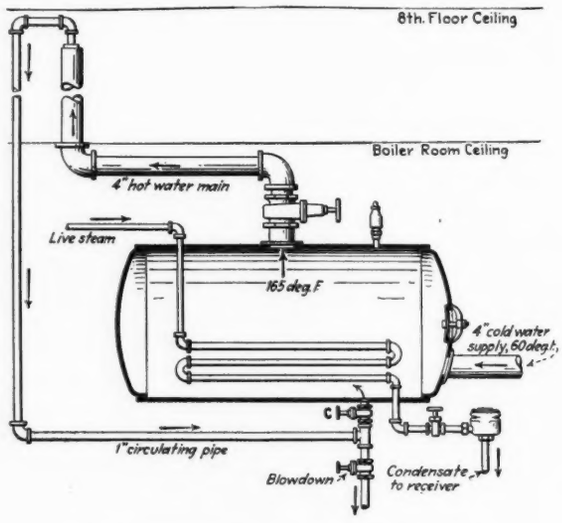
Newark, N. J. W. F. SCHAPHORST.

[A careful reading of the editorial referred to by Mr. Schaphorst will reveal that it took no positive stand, but asked a question of the industry. Users of ice will gain little comfort to learn that air agitation is needed to eliminate the filth dropped into the can from the puller's shoes. As for impurities carried in the water, most of the insoluble matter can be removed by filtration, while the soluble salts will concentrate in the core water, which can then be removed as at present. Citations as to municipal laws against natural ice prove nothing beyond the activity of interested parties. Has anyone proved by impartial tests that raw water, properly filtered, will not make a sanitary ice without air agitation?—EDITOR.]

How Faulty Water Circulation Was Improved

COMPLAINTS were received from tenants in an office building that the hot-water taps had to be held open and the water allowed to run for several minutes before it flowed hot. Poor circulation appeared to be the trouble, so the best way of correcting the trouble seemed to be in the installation of a small circulating pump. However, the budget did not permit this expenditure and some other means had to be devised. It was decided to put a blowdown valve in the gravity circulation pipe, so that a circulation could be set up in this pipe any time by opening the blowdown valve. Then each morning before the tenants arrived the circulating pipe was blown down, after first closing valve *C*, until the water discharged felt warm. With this arrangement the water consumption was materially reduced. LESLIE W. ROSS.

Toronto, Ont.



General arrangement of water heating system

A.S.M.E. and A.S.T.M. Seek Better Metals for High Temperatures

On June 22 1,000 members and guests of the A.S.T.M. and A.S.M.E. came together in Chicago to speed the search for better metals for high-temperature service. Power-minded A.S.M.E. members outlined their present best practice and their urgent needs. A.S.T.M. members told what the future might bring.

MORE THAN 1,000 members and guests of the American Society for Testing Materials assembled at Chicago during the week of June 22 for the thirty-fourth annual meeting of the organization. A principal attraction of the session was a symposium of 27 papers on the effect of temperature on the properties of metals, held jointly with the American Society of Mechanical Engineers. The symposium, presented under the sponsorship of a joint research committee of the two organizations, carried out and brought up to date work which was initiated with an earlier symposium in May, 1924.

No Papers Read at Meeting

The method of handling the symposium was one that might well be followed in future cases. The papers had previously been distributed among the members of the two organizations, with the request that both written and oral discussion be prepared. The papers fell logically into two classifications: "Trends and Requirements for Metals at High and Low Temperatures"; and "Properties of Available Metals for High and Low Temperature Service." A member of the symposium committee prepared a comprehensive abstract of each group of papers, which he then presented expeditiously at one of the two symposium sessions. In this manner it was possible to devote the greater part of the time to discussion which brought out many points of debate and much valuable information that has become available in the several months since the papers were originally prepared.

Requirements for Boilers and Superheaters

Three papers of particular interest to *Power* readers were devoted to metal needs under the increasingly severe requirements of the power plant. These dealt respectively with metals for boilers and superheaters; metals for steam turbines; and finally metals for valves, piping and so on.

The paper by H. J. Kerr, in charge of research development and service department of the Babcock & Wilcox Co., confined itself to the boiler field, but within that field clearly outlined the metallic needs of the immediate future.

For high-pressure boiler drums, headers, high-pressure tubes exposed to radiant heat, superheater tubes of high-pressure boilers and for superheater headers not subjected to gas temperatures, Mr. Kerr asked for metal that can be welded by the electric arc or acetylene torch in such a way that the resulting material will maintain its strength and ductility. He stressed this requirement as primary.

In all cases he called for a composition that can be manufactured without unusual difficulty, and that will stand a reasonable amount of cold working without impairment.

In addition, the special requirements were as follows: For material for high-pressure drums, headers, etc., he specified a tensile strength of 100,000 lb. per sq.in., a ductility approaching that of 0.30 per cent carbon steel, and stability for an indefinite period at temperatures up to 750 deg. F.

For high-pressure boiler tube material exposed to radiant heat, ability to carry a stress of 10,000 lb. per sq.in. at 1,000 deg. F. with a creep rate of 1 per cent in 100,000 hr.; ductility equal to that of plain carbon steel up to at least 1,000 deg. F., preferably 1,200 deg. F.; ability to withstand the corrosive action of high-temperature flue gases from fuel containing sulphur; ability to withstand oxidation in contact with steam and water of the nature normal to boilers; ability to remain stable indefinitely at 1,000 deg. F.

The special requirements for superheater tubes were an ability to stand a stress of 10,000 lb. per sq.in. at 1,300 deg. F., with a creep rate of 1 per cent in 100,000 hr.; ductility equal to that of plain carbon steel to a temperature of at least 1,300 deg. F., preferably 1,500 deg. F.; ability to withstand the corrosive action of high-temperature flue gases from fuel containing sulphur; ability to withstand oxidation in contact with steam, with the steam temperature of the order of 1,100 deg. F., and metal temperature of the order of 1,200 to 1,300 deg. F.; stability for an indefinite period at a temperature of at least 1,300 deg. F., preferably 1,500 deg. F.

Mr. Kerr's paper attracted more discussion than any other single presentation of the symposium. In general, it was thought that the requirements which had been set up by the author were somewhat severe, although it was the considered belief of several of the engineers present that the requirements will be met, in fact that metallurgists are now approaching them.

More Attention to Cost of Materials

Prof. A. E. White, University of Michigan, commented on the prime importance of cost of materials. He pointed out that it is conceivable that the cost of special materials can be so great that the carrying charges offset any savings that would otherwise result. He considered that proper control of the physics of steel making is of greater importance than composition in the production of large, thick plates, and that ingot mold design and proper pouring temperature will assist materially in keeping the gases in zones where they will do the least harm. He pointed out further that the severe requirements for superheater tubes have been met so far as creep is concerned in only one instance, and that there is some doubt even in this case, of the correctness of the results. The requirements as to manufacturing difficulties and cold working, he said, are adverse to present high creep-value alloys, which are notoriously tough and resistant to cold working, with the exception of the 18-8 alloys which show a creep value at 1,350 deg. F. of only 2,800 lb.

Prof. F. G. Straub, University of Illinois, emphasized the importance of cost and stressed the need for the best available materials to meet all possible contingencies. Although present materials may suffice under the proper circumstances, conditions may arise where they will fail through no fault of their own.

Power-plant operators will second Mr. Kerr's requirements, said J. H. Walker, engineering assistant to the general manager of the Detroit Edison Company. However, he felt that the creep requirements are rather severe, and questioned whether the advantage of thinner tubes of more costly materials would justify their cost. He stated that the requirements cited are far in advance of any thing now available. He mentioned the fact that experimental work is now being carried out to determine the suitability of corrosion-resist-

ing coatings on boiler tubes of metals not themselves capable of resisting high-sulphur gases.

Evidence indicates, in the opinion of H. B. Oatley, vice-president of the Superheater Company, that metallurgists are solving the problem of the difficult requirements set forth by Mr. Kerr. He suggested that the specification of "indefinite life" for super-alloys as given by Mr. Kerr, should be modified to call for "durability and life not less than that given by materials we now use, for the operating conditions of the pre-high-pressure, high-temperature period." He also wished to have specified a workability equal to present materials. He believed that Mr. Kerr had not sufficiently emphasized the importance of cost.

Large Creep Limit for Superheater Tubes

In the opinion of C. W. Gordon, chief engineer of the industrial division of the Superheater Company, Mr. Kerr's specifications were perhaps unduly op-

●

One very definite problem which has not been met on present-day cycles is the corrosion of steel by sulphur gases at temperatures below 300 deg. F. Here the problem is not a stress-temperature problem, but is almost wholly a corrosion problem, resulting from sulphur in the gases.—H. J. Kerr.

●

timistic, and also somewhat too severe, so far as they touched on creep. For superheater tubes he believes that a creep requirement of one per cent per year is more economical than that proposed. He stated that a life of ten years of continuous service for superheater tubes is excellent, and that a growth of 10 per cent would cause few if any failures. Incidentally, he pointed out, no central station is modern for ten years at the present state of the art. He doubted that superheater units should be designed for ten years.

Mr. Kerr's creep limit requirements could safely be doubled, in the opinion of I. L. Wise, of Chicago, who pointed out that the probable maximum life of a power plant is 15 years, of which about 79,000 hours only would be actual operation. He stressed the fact that future improvement must come from higher temperatures and pressures, coupled with regenerative and reheating cycles so as to decrease losses in the condenser, and predicted that considerable improvement must come in boiler materials before the use of binary cycles will become an economic possibility.

Steam Turbine Materials for High Temperatures

Increasing steam temperatures have confronted turbine designers with many difficulties. These were outlined in a paper by R. C. Allen, manager central station turbine division, Westinghouse Electric & Manufacturing Co. Following is an abstract of his paper:

At present, operating temperatures around 850 deg. F. are commonly regarded as standard. Steam temperatures of 900 to 1,000 deg. are being considered for a number of projects. It is possible to design central station turbine equipment for average pressures and temperatures, and with materials now available, so that the rate of growth will not exceed 0.01 per cent per year. This is the value a number of builders have adopted as a standard design for high-temperature turbine parts.

Effect of Creep on Clearance

For normal cylinder, spindle and blade construction an average creep rate of 0.01 per cent per year is adopted where possible. This creep rate, however, introduces a problem of clearance. For example, with a turbine cylinder of 50 in. internal diameter the increase of diameter would amount to 0.075 in. at the end of 15 years. This internal diameter is approximately that of the first reaction stage of a 35,000 kw., 1,800 r.p.m. turbine. The effective height of the first row of blades is about 2 in., and the tip clearance 0.050 in. If the extension or increase in diameter were applied to the cylinder alone, the diametral increase of 0.075 in. would increase the clearance to 0.0875 in., a gain of approximately 75 per cent. As a result, the efficiency of such a high-pressure reaction stage would be impaired by 7 per cent.

Actually, the tangential stress in the spindle body is such that it also will grow at approximately the same speed as the cylinder, so that the clearance would not change as rapidly as indicated.

The maximum working stresses in high-pressure turbine blades may reach 20,000 lb. per sq.in. at normal speed. Only a very small part of this (about 10 per cent) is accounted for by centrifugal force. The remaining 18,000 lb. per sq.in. is the stress produced by the pressure difference over the row, and by the driving reaction of the steam. The resulting bending displacement will continue unitl it is equalized by centrifugal force. This compensation by centrifugal force is not found in the stationary blades, so the stresses in them must be limited to values such that the bending deformation in a 15-year period will be small.

The cut shows the development of a high-pressure joint for an operating temperature of 900 deg. F., and an internal pressure of 1,400 lb. per sq.in. With a 60-in. internal diameter the average stress in the 7-in. thick cylinder wall would be 6,000 lb. per sq.in. The Lamé formula indicates a local tangential stress at the bore of 6,780 lb. per sq.in.

Based on short-time tests at 100 deg. F., this material would show a tensile strength of 100,000 lb., a proportional limit of 60,000 lb., a 20 per cent elongation in 2 in., and a 45 per cent reduction in area.

The most astonishing part of the illustration is found in the large studs that would be necessary for such a cylinder. The nominal thread diameter is 11 in. The nuts are placed alternately, one head being up and the other down, in order to secure their maximum flange strength, and so that there may be sufficient room for a wrench. The studs are designed for an average unit stress of 7,500 lb. per sq.in. and a total load of 680,000 lb. The stud material should have the following composition:

	Per Cent
Carbon	0.07 to 0.12
Manganese	0.30 to 0.60
Phosphorus (maximum)	0.03
Sulphur (maximum)	0.03
Silicon (maximum)	0.35
Nickel (maximum)	0.60
Chromium	11.50 to 12.50

Internally Heated Studs

It is not good practice to tighten such studs by the ordinary process of driving up, as the high-quality alloy steels have shown tendency to crack under the effect of sledge hammer blows on a wrench. Central holes are provided to permit internal heating of the studs, so that the nuts may be tightened. The tightness is judged by the amount the stud shanks are stretched when cooled to the cylinder temperature.

In high-temperature turbines with long studs or bolts and horizontal joints the heating of the main flange may take place so rapidly that the studs will be stretched beyond their yield point when

●

A creep rate of 0.01 per cent per year for the major part of high temperature turbines appears to be a satisfactory practical limit. New bolt steels that can be operated at higher stresses than the present materials are needed. Higher grades of steel that can be cast and welded are required for cylinder work. The present spindle and blading materials should serve until new limits are encountered.—R. C. Allen.

●

starting the machine from the cold condition. In some cases it has been necessary to arrange a starting program in which heating steam is admitted into the clearance holes around the studs at the same time that steam is turned into the main turbine for the purpose of warming up the cylinder and spindle.

Welding Eliminates Many Pipe Flanges

In the case of pipe flanges, there has been some trouble from bending or dishing. This has been taken care of by thickening the flanges. Relieved-shank bolts of nickel chromium steel are used.

The present tongue-and-groove joint standards have not given serious trouble, although there has been some permanent deformation of the tongue. With modern welding methods the number of bolted steam-pipe joints in the station can be greatly reduced. Bolted joints are only needed where parts must be designed for periodic inspection, such as steam strainer covers, valve bonnets, etc. It is expected that there will be a marked increase in the application of electric welding in central stations.

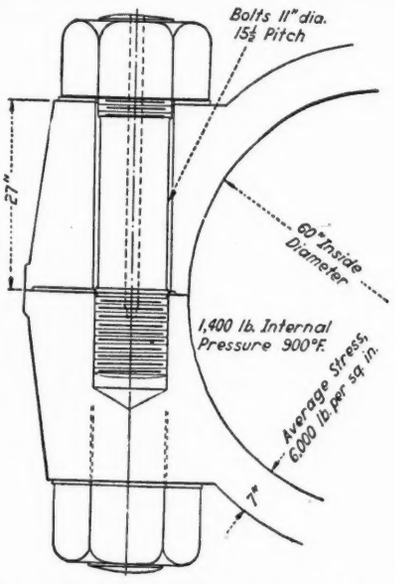
From the foregoing it may appear that turbine builders are well supplied with materials for any operating condition yet projected. This is far from the truth. Progress toward the end of securing better bolt steel will offer great relief to the turbine constructor. Alloy steels from which castings can be made, and which have better properties at elevated temperatures, are most urgently needed. Alloy steel castings should be easy to repair by welding. In the field of fabricated cylinders, alloy steels that can be welded, and at the same time formed into shape suitable for the production of turbine cylinders, will be in demand.

Information Needed on Torsional Creep

Discussing Mr. Allen's paper, S. Timoshenko, University of Michigan, commented on the design of machine parts from the standpoint of creep. While, he said, the simplest method is to use known data obtained under less severe conditions, and allow for the more severe tests to be met in the high-temperature, high-pressure field, it is more rational to base design on the actual, known, allowable creep rate for each individual part under the operating conditions.

However, said Professor Timoshenko, most of the known information concerns tensile creep tests, while torsional creep data are badly needed. Little of this is available. What is known on bolts and studs cannot safely be extrapolated to cylinders under internal pressure. Work on torsional creep is now being done at the University of Michigan. Such work is easier than tensile tests, and will result in the development of formulas which will permit the design of smaller, cheaper parts with safety.

Comment on Mr. Allen's remarks anent the desirability of developing a better material than silver solder for brazing in turbine blades was presented by R. H. Leach, of Handy & Harman, who pointed out that silver solder used on stainless steel showed a tensile of 70,000 lb. at room temperature, and 31,400 lb. at 1,000 deg. F.



High-pressure cylinder (described in paper of R. C. Allen) has studs of 11-in. diameter

Pipe and fittings can be allowed a creep of three per cent in 200,000 hours with safety. Valves, bodies and parts must be held to closer limits of total deformation, because of the movable parts. Studs of alloy steel are necessary in all high-temperature installations.—F. W. Martin.

Metals for High-Temperature Piping

The metallurgical requirements for high-temperature steam piping were outlined in the paper by F. W. Martin, assistant mechanical engineer, Sargent & Lundy, Inc., Chicago, Ill. For pressures above 400 lb., and for temperatures up to and including 750 deg., said Mr. Martin, most designers have limited themselves to seamless steel tubing with a minimum tensile strength at room temperature of 62,000 lb. per sq.in. From the point of view of failure, he pointed out, a steel pipe or fitting might be permitted a growth of 5 to 6 per cent. The actual permissible creep, however, would be less than the minimum necessary from a safety standpoint, and a working range of 2 to 3 per cent would probably be permissible, he said.

For fittings to be used at 850 deg., he said that at least one firm is employing a chromium-nickel alloy cast steel with a higher short-time strength at 850 deg. F. than carbon-steel castings have at 750, and a strength at 1,000 deg. F. equal to that of carbon steel at 750 deg.

Gate Valves and Flanged Joints

Referring to gate valves, Mr. Martin pointed to the necessity of ring seats having a coefficient of expansion practically the same as the body to avoid their becoming loose under pressure with a resulting steam leak, or bulging that prevents the tight closing of the valve. In addition, he pointed out, the ring seats must possess a high resistance to galling and scoring, and must be strong enough in compression, at the operating temperature, to withstand the full load imposed by the steam pressure on the gate when the valve is closed.

The use of carbon steel bolts in high-temperature steam pipe lines, said Mr. Martin, has been strongly discouraged, because of their tendency to become brittle when used for a long period at high temperature. He showed that the stresses far exceeded those due to steam pressure alone. Fitters, Mr. Martin pointed out, often put initial stresses from 30,000 to 65,000 lb. per sq.in. on the studs in tightening up the joints. In addition, the studs are heavily stressed by differential expansion when the lines are first heated up.

Judging from the amount of discussion, the metallurgical requirements of piping and valves was a subject of much interest. Sabin Crocker, engineering division of the Detroit Edison Company, commented at length on a small experimental 10,000-kw. turbine and boiler which were recently installed by his company at Delray Power House No. 3, to operate at 1,000 deg. and 400 lb.

Mr. Martin in his paper had referred to this plant as making considerable use of 18-8 chrome-nickel steel. Mr. Crocker pointed out that in the cooler section of the superheater, operating not over 950 deg., the material is ordinary carbon steel, although in the hotter section, where a temperature of 1,200 deg. is found, a special silicon variation of the 18-8 steel is used. The forged pipe from the superheater outlet header to the turbine lead is 18-8 steel, with cast fittings. An experimental valve in this line is of a chrome-molybdenum alloy. Mr. Crocker reported that experience had shown that while there is some strain hardening to be expected in stainless steels, the deterioration is so slow that the material is still tough and ductile after 6,400 hours.

P. W. Brace, Westinghouse Electric & Manufacturing Company, suggested materials of different thermal expansion to avoid the seizing of screwed connections. He was also of the belief that future development of the alloys of iron, cobalt and nickel might permit worthwhile advances in high-temperature steam practice.

More About Flange Bolts

A method for investigating bolt stresses in steam-line flanges was described by H. E. Haller, president of the National Valve & Mfg. Co., Pittsburgh, who said, however, that the method had not yet been carried far enough to permit forecasting the stresses in bolts used in flanges of design other than those that have been tried. Since the bolts are cooler than the flanges, considerable strain may be set up unless the flanges dish to relieve the additional tension. Using a particular type of flange it was found that the bolts were 10 deg. cooler in a 2-in. line, the difference increasing to 30 deg. on a 10-in. line, with steam at 1,350 lb. and 900 deg. Each 10 degrees causes, with this type of flange, an increase in bolt stress of 2,000 lb.

From Among Readers' Problems

Conducted by
L. H. MORRISON

HEATING WITH EXHAUST STEAM—*Is it possible for the radiators used for heating our building to take the place of a surface condenser when operating a steam engine running condensing? If so, how shall the calculations be used to find out how much radiating surface is necessary for each pound of exhaust steam to be condensed?*

Assuming that this is not practical, is it practical to heat a building by means of water which has been used in a surface condenser to condense the steam, and which has a temperature of about 150 deg. F.? If so, how many times more radiating surface is necessary than that used when the radiators are heated by exhaust steam? R.M.B.

It is quite common practice to use the exhaust of steam engines in building heating systems. Such operation, however, generally requires a slight back pressure on the engine. This is necessary when the supply of exhaust steam from the engine is greater than the capacity of the heating system to condense. Under such circumstances the pressure of the heating system will build up until the relief valve opens and steam is lost to the atmosphere. If the supply of exhaust steam is less than the maximum demand of the heating system, then it is possible to operate the engine against a pressure slightly less than atmosphere, provided the heating system is arranged for operation with a vacuum pump and with not too large a pressure drop.

One square foot of equivalent direct radiation emits 240 B.t.u. per square foot per hour. Equivalent square feet is the rating given by radiator manufacturers in their catalogs. With steam at about atmospheric pressure, and at room temperature of 70 deg., a radiator will condense about 0.25 lb. of steam per hour.

There are also a great many factories and buildings using condenser circulator water for building heating purposes. This arrangement permits operating the engine at somewhat better vacuum than is possible in using the steam exhaust direct in the heating system. It, however, requires pumps for circulating the water in the heating system, and a somewhat increased amount of radiation. It also requires that the heating system be of the hot-water type, piped for this purpose. With water at 170 deg. a hot-water radiator will dissipate 134 B.t.u. per square foot per hour when the room temperature is 70 deg. A water temperature of 170 deg. is usually used in the design of hot-water heating systems. With water at 150 deg. the radiator would dissipate about 100 B.t.u. per square foot per hour. Or, to put it another way, to dissipate the same amount of heat, a hot-water system using water at 150 deg. would have to have at least 2.4 times as much radiator surface as would a steam heating system. However, if the water in the radiator were at 170 deg., the hot-water system would have to have only about 1.8 times as much surface as the steam heating system.

SIZE OF BOILERS FOR PLANT—*We are contemplating building a new laundry power house, the installation to be two 5,000-sq.ft. water-tube boilers. Our maximum demand for steam at present is 18,000 lb. per hour; half of this is used for power, the other half of this is used for process work at 125 lb. gage.*

Would not two 3,500-sq.ft. or three 2,500-sq.ft. boilers be better suited for the above steam demand? K.A.H.

With a maximum steam demand of 18,000 lb. per hour, a 5,000-sq.ft. boiler would be carrying but little more than normal rating, which would indicate that at other times the boiler would be running below its rating. The average efficiency would be better if the boiler was operating above its normal rating.

A better arrangement might be to install three 2,500-sq.ft. units, which would permit flexibility in operation. However, as in all such instances, local conditions determine the best arrangement, since the number and durations of the peak loads and the amount of the average load must be considered when choosing the boiler capacity. The prospective plant is large enough to justify the employment of a consulting engineer to make a study of the situation.

DETERMINING THE THICKNESS OF HEADS—*We desire to get as much technical data as we can on the theoretical determination of the proper thickness of materials to be used in spherical heads constructed of steel plate, when these heads are subjected to a uniform pressure applied to the convex surface of the head. There is, of course, a standard formula for determining the thickness of such heads when pressure is applied to the concave side, which puts the material in tension; but when the pressure is applied to the reverse side, part of the material is in compression instead of tension. I have been unable to find any textbooks that give a treatment of this problem.* E.L.G.

This problem is fully covered in the A.S.M.E. Boiler Code in the chapter on Dished Heads. Here it is stated that for heads where the pressure is on the convex side, the maximum allowable working pressure shall be not more than 60 per cent of that for heads of the same dimensions, with the pressure on the concave side. In marine practice, such as starting tanks for Diesel engines, a factor of 70 instead of 60 per cent is sometimes used, in view of the very stiff heads of such tanks.

PREVIOUS QUESTION
DISCUSSED BY READERS

THE QUESTION

IS THERE any advantage in adding water to lubricating oil from diesel crankcases before it is passed through a centrifuge? Is the water temperature of any moment? J.F.

IN THE PUBLIC SERVICE PLANT nearby there are 6,000 hp. of diesel engines in three units. Oil is cleaned in batches of 400 to 500 gal. by two medium-sized bowl-type centrifugal separators. One man is assigned to the job, and is encouraged to experiment for best results. It has been found more satisfactory to add nothing to the batch, as the addition of water simply appeared to make something more to separate from the oil.

The second part of the question is more important, by far, than the first. The temperature of the batch at the moment of separation has a great influence on the performance of the

centrifuge, inasmuch as the efficiency of separation increases in much greater proportion than the increase of temperature, and 190 deg. F. is a minimum.

For instance, the difference between separation at 180 deg. and that at 190 deg. is almost the difference between success and failure. Reasoning from these results, I should say that if one were determined to use some water it should be as hot as possible.

THOMAS C. HULTON.
Abras Grandes, Prov. the
Camaquey, Cuba.

ALTHOUGH it is not necessary to use both water and heat in centrifuging crankcase oil from diesel engines, nevertheless both are advisable for the following reasons:

Crankcase oil has a specific gravity around 0.900 at 60 deg. and has a coefficient of expansion per degree Fahrenheit of 0.00041, so that at 200 deg. F. it has a specific gravity of about 0.840. Water expands irregularly, the expansion curve being something like a parabola instead of a straight line, the coefficient being about 0.0002 at 100 deg. and 0.00038 at 200 deg., so that the difference between the specific gravities of the two liquids is raised from 0.100 at 60 deg. to 0.122 at 200 deg., an increase of over 20 per cent. The increased difference in specific gravity makes it easier to separate the hot water from the oil.

Another advantage of heat is to lower the viscosity of the oil, permitting greater capacity in the centrifuge.

Lubricating oil contains, roughly, six parts of carbon to one of hydrogen, and in the high heat of the cylinder the hydrogen is burned away first, leaving the carbon in so finely divided form that it will pass through any filter except fuller's earth or some similar agent. Hot water, preferably admitted in the form of live steam, seems to gather the carbon particles together into a gummy mass, making them more amenable to centrifugal force. In this form, with a properly designed machine, the water will carry out the residue that would otherwise accumulate in the bowl and thus make the machine self-cleaning.

Well-centrifuged oil will be darker colored than the original oil, but its use is in nowise impaired, as the extremely fine carbon that escapes the centrifuge is graphitic in nature and assists rather than retards lubrication. As before implied, filtering through fuller's earth will decolorize it, and if carried far enough, render it water-white, but the loss is great, the filtering expensive and tedious and no good purpose is gained.

Cleveland, Ohio L. R. BAKER.

THERE ARE at least two possible advantages in adding water to diesel crankcase oil before passing it through a centrifuge. In the first place, the water added may act as a carrier and assist in removing particles of solid matter, such as carbon, dirt, metal, etc. There is a tendency for such particles to lodge in the centrifuge and interfere with its efficient operation. The addition of water furnishes a means of keeping the machine in operation for longer periods of time without the necessity of cleaning, and, at the same time, doubtless makes it more effective in removing these solid particles.

The other advantage is due to what may be considered a chemical reaction taking place between the water and certain organic acids normally found in used oil. It has been found that the common mineral oils undergo oxidation while in service, the rate of oxidation varying with different oils and being more rapid at the higher operating temperatures, especially where continual pouring or splashing occurs. The result of such oxidation is to convert certain of the hydrocarbon constituents of the oil into weak organic acids.

There is no great danger of corrosion from these acids, for at low concentrations they do not normally attack metal surfaces. But they seem to have a great affinity for water, with which they combine to form emulsions and sludge. This latter tendency makes them objectionable in any lubricating system where there is a possibility of water being introduced, for this sludge may stop up oil lines, foul cooling surfaces, or otherwise interfere with effective lubrication.

It is just this affinity for water, however, that makes it easy to remove these acids. When water is added before centrifuging the acid is absorbed by it, and the resulting sludge is removed by the machine. If clean water of a neutral or slightly alkaline condition is used it is hard to see how the results could be otherwise than beneficial. M. F. KNOY.

Beaumont, Texas.

THE REASON for washing an oil with water before it is centrifuged is to remove the acids, which are more soluble in water than in oil. Hot water is best, due to the greater solubility of the acids at higher temperatures. The acid condition is usually found in circulating systems, especially in turbine oiling systems, and is the result of oxidation.

The principal contamination of the oil in a diesel crankcase is from metallic particles and sand and dirt, and not from acidity produced by oxidation. Since this is the case and the purpose of washing with water is to remove the acid condition, there would be no particular advantage in washing the oil before it is put through the centrifuge.

Dallas, Texas. E. F. GRAHAM.

IN THE MAJORITY of oil-purification systems using the batch method water is not added before centrifuging. In the batch system the water would be used for direct heating of the oil in the dirty-oil tank. This would also cause the heavier particles to settle out as the oil was heated. When the oil is heated to around 180 deg. it is drawn off from the top of the water and centrifuged.

In our plant we use the batch system, but do not use water with the oil. We have operated four years now and our bearings show practically no wear. Our oil is centrifuged once each week. It would be hard to say which is the best system without knowing which method of centrifuging is to be used; also the type of engine and the amount of oil to be handled. In some types of diesel engines the cylinders are closed off from the crankcase. We find very little carbon in the oil; so it would hardly pay to use water to settle out the carbon; the centrifuge will take care of this. If the oil has a lot of carbon it will help to use water, as the centrifuge bowl will not have to be cleaned so often and will not have to remove as much dirt.

WM. W. DINGWALL.

Walthill, Neb.

A Question for Our Readers

THE METHOD of firing our boilers was recently changed to pulverized fuel, but no provision was made for igniting the coal. We wish now to install a standard type of oil ignition torch and desire advice as to its best location with respect to the burners. The burners are of the horizontal turbulent type located about 5 ft. above the furnace floor on either side of the centerline. C.J.C.

Suitable answers will be paid for[1] and published in the Aug. 11 number.

[1]As an alternative to cash payment for answers published, readers may select any one of the following books. (Be sure to state the book desired.)

Morrison's *American Diesel Engines*; Walker and Crocker's *Piping Handbook*; Norris and Therkeisen's *Heat Power*; Emswiler's *Thermodynamics*; Church's *Steam Turbines*; Uehling's *Heat Loss Analysis*; Croft's *Steam Power Plant Auxiliaries and Accessories*; Powell's *Boiler Feed Water Purification*; Osborne's *Power Plant Lubrication*; Moyer and Fritz' *Refrigeration*; Rietschel-Brabee's *Heating and Ventilation*; Annett's *Electric Elevators*.

THE ENGINEER'S

Municipal Plant Progress

MUNICIPAL OWNERSHIP AND THE CHANGING TECHNOLOGY OF THE ELECTRIC INDUSTRY IN THE WEST NORTH CENTRAL GEOGRAPHIC DIVISION. *By Paul Jerome Raver, assistant professor of public utilities, Northwestern University. Published by the Institute for Economic Research, 337 East Chicago Ave., Chicago, Ill.; 1931. Paper, 7x10½ in.; 92 pages; charts and tables.*

MUNICIPAL OWNERSHIP is holding its own in the electric light and power industry in terms of generating capacity of plants, although it has definitely failed to do so in terms of the number of plants. This is the trend indicated by Professor Raver's study, which covers the states of Nebraska, Iowa, North and South Dakota, Minnesota, Kansas and Missouri. These seven states on April 1, 1930, contained 36.5 per cent of all the municipally owned generating establishments in the country.

As Professor Raver analyzes his figures, he finds what appears to be a normal plateau of municipal ownership development, and that this plateau is now more definitely marked out than at any time previously. In other words, conditions in the industry as regards publicly owned plants seem to be settled down and the "battle line," if it might so be called, between private and public operation is being stabilized.

The period of rapid expansion of privately owned systems is probably over and with it has passed the period of rapid acquisition of municipally owned plants. Seemingly the interest of private capital has turned since 1926 from the acquisition of new plants to the building up of existing markets. While the sale of municipal plants to private interests has slowed down, so has the establishment of new plants.

Public production of electricity is now on a far different basis than in the early period of development. Then there were many cities and villages making their own current in little plants. As privately owned systems expanded their facilities the smaller sized plants in many instances were eliminated. Numbers of them still remain, but the outstanding examples of municipal ownership are to be found in the larger .ies.

The continued increase of horsepower capacity by public plants in the face of their greatly diminished number is explained by the expansion of these larger municipal plants. Specifically, out of a total of 690 generating plants originating in this territory between 1903, when Professor Raver's study begins, and April 1, 1930, when it closes, 527 or 76 per cent changed from municipal to private ownership. Yet these 527 stations took with them only 15.7 per cent of the gross horsepower capacity.

The position of the smaller municipal plants has lately been bolstered by the promotion of the diesel engine. It appears to have certain advantages for the minor municipal station and a number of communities have found it a means of modernizing obsolete equipment. In addition manufacturers of this engine have encouraged other communities to embark on municipal ownership. Private capital has thus come to the aid of municipal enterprise and in some instances has improved the competitive position of the public plant.

This study is the first of a series, which, when completed, will present the economic and technological trends in municipal ownership for the country.

Revised Callendar Tables

THE REVISED HEAT DROP TABLES (1931). *Calculated by Herbert Moss from the new data and formulas of the late Prof. H. L. Callendar. Published for the British Electrical and Allied Industries Research Association by Edward Arnold & Company, 41 Maddox St., London, W1, England. Cloth, 8x11 in.; 76 pages. Price, 12s. 6d.*

IN 1917 the British Electrical and Allied Manufacturers Association published heat-drop tables based on the equations of the late Professor Callendar. This table included pressures up to 400 lb. Additional tables, published in 1925, extended the range to 2,000 lb., these values being obtained largely by extrapolation. The present volume is calculated on the basis of Professor Callendar's actual experiments up to 4,000 lb. pressure and 750 deg. F.

These tables are designed to give directly the available adiabatic heat drop in B.t.u. from any given initial pressure and temperature to a given final vacuum. The principal table covers gage pressures from 100 to 3,200 lb.; initial temperatures from 675 to 1,000 deg., and vacuum from 27.0 to 29.5. Everything possible has been done to make this table easy to use. The typography is excellent. Giving the initial and final pressure as gage pressure and vacuum respectively simplifies the use of the tables.

A special table for exhaust turbines gives heat drops for saturated steam with initial pressures from 14 to 19 lb. absolute, and exhaust vacua from 29.0 to 29.5. Another table gives conversions for initial and final temperatures in the Fahrenheit, Centigrade and Réaumur systems, and for pressures in pounds per square inch, kilograms per square centimeter, and atmospheres (two different definitions).

The preface gives a special short-cut method of interpolation.

Flue-Gas Corrosion

THE CORROSION OF POWER-PLANT EQUIPMENT BY FLUE GASES. *By Henry Fraser Johnstone. Published as Bulletin No. 228 of the Engineering Experiment Station by the University of Illinois, Ill.; 1931. Paper, 6x9 in.; 120 pages; illustrations, charts and tables. Price, 65c.*

AMONG THE PROBLEMS that have arisen as a result of the use of lower grade coals in large power stations is the increase in corrosion of equipment, caused by the products of combustion. The simultaneous decrease in the exit gas temperatures and the increase in the sulphur content of the coal, dictated by modern practice, as well as a change in the character of the ash, have produced a condition most favorable for corrosion. The deterioration in the economizers and preheaters, especially at temperatures where the metal may exist below the dew-point of the gases, is quite severe.

The use of higher operating pressures has also entered into the development of the problem because of the greater prevalence of leaks, a condition which is also favorable to rapid corrosion. In some cases the corrosion has been so severe that the life of a preheater tube is not greater than one year and failures in the colder sections of the economizer have taken place in as short a time as three months.

The investigation reported in this bulletin was undertaken to find out what factors are contributing most to the corrosion, and then study methods of their elimination or their prevention by some other means. The bulletin describes the conditions which are present in flue gases that cause corrosion and some of the steps that may be taken toward their elimination. The reactions that take place in a boiler furnace are discussed and their effect on corrosion and slag formation are brought out.

A description of the experimental work carried on in the laboratory on corrosion and its results are also given. These substantiate the ideas of the cause of corrosion suggested by the plant data. The results of tests on various corrosion-resisting alloys and protective coatings under the conditions existing in the flue gases are reported. A description is also given of new methods for the determination of the dew-point and sulphur dioxide and trioxide concentrations in flue gases.

Made in cooperation with the Utilities Research Commission of Chicago, the study contains much plant data.

BOOKSHELF

Machine Design

APPLIED KINEMATICS. *By J. Harland Billings, professor of mechanical engineering, Drexel Institute. Published by the D. Van Nostrand Company, 250 Fourth Ave., New York City; 1931. Cloth, 6x9 in.; 173 pages; illustrations and diagrams. Price, $2.50.*

BY THE EXTENSIVE USE of graphical methods and simple, lucid explanations, this book presents a comprehensive and understandable treatise on the subject of mechanisms. Starting with a chapter on motion in machines, it covers the theory of mechanisms, parallel and straight-line mechanisms, velocities and accelerations in mechanisms, cams, gearing and gear combinations, flexible connectors and special mechanisms.

A wide variety of practical problems are included to illustrate applications of the theory. General methods of solution are given, with particular attention paid to the graphical method. Special treatment is accorded the subject of acceleration, consistent with the modern trend toward increasingly higher speeds in machines. The general solutions for acceleration in direct-contact mechanisms are original with the author and provide a unique method of attack for such problems.

While the book is written primarily for use as a text in technical schools, it will be a valuable aid to the practicing engineer who wishes to keep abreast of modern theory and practice in machine design.

Modern Drafting Practice

ELECTRICAL DRAFTING AND DESIGN. *Second Edition. By Calvin C. Bishop, head of the department of drafting and design, Technical High School, Buffalo, N. Y. Published by the McGraw-Hill Book Company, 370 Seventh Ave., New York City; 1931. Cloth, 6x9 in.; 190 pages; diagrams and tables. Price, $2.*

WRITTEN, as the author states in the preface, "to bridge the gap between the usual course in mechanical drafting as taught in technical and vocational schools and the work a young man is required to do in the office of an engineer, a contractor or a power company," this book contains essential information on modern practice in electrical and mechanical drafting and design. By means of examples taken from actual practice the author explains the applications of mechanical drawing to generators, motors, switchboards, outdoor substations, lighting and residence wiring. Information is included on the use of electrical symbols, together with tables of engineering data and detailed dimensions of standard equipment.

Features of the second edition include the latest changes in the underwriters' rules, specifications on new apparatus made by various companies and new drafting-room standards. Several new problems in simple drafting work have been added, together with new chapters on an 11,000-volt power or substation installation.

In its revised and enlarged form this book should prove even more helpful to those engaged in individual study of electrical drafting and design.

Mechanical Testing

MECHANICAL LABORATORY METHODS. *Fourth Edition. By Julian C. Smallwood, associate professor of mechanical engineering, Johns Hopkins University, and Frederic W. Keaton, assistant professor of mechanical engineering, Sheffield Scientific School, Yale University. Published by the D. Van Nostrand Company, 250 Fourth Ave., New York City; 1931. Cloth, 6x9 in.; 375 pages, 131 illustrations, numerous tables. Price, $3.50.*

THIS FOURTH EDITION of the well known laboratory manual contains much new material dealing with equipment developed since the volume was first published, as well as a thorough revision of the information contained in previous editions. It has been written specifically for student use, yet it contains a wealth of material that should be of great value to the practicing engineer, particularly to the man whose education and textbooks on the subject date back over a period of several years.

The authors are to be congratulated upon omitting discussions of thermodynamics, which are available in other books, and devoting the space to laboratory test methods.

BRIEF REVIEWS

THE AUTOBIOGRAPHY OF AN ENGINEER. By William LeRoy Emmet. Published by the Fort Orange Press, Albany, N. Y.; cloth, 213 pages, illustrated.—A human document containing much first-hand information on the development of the steam turbine in this country. Enlivened with interesting anecdotes, it presents intimate glimpses of many of the personalities who were responsible for progress in the power field.

THE ART OF LEARNING. By Walter B. Pitkin. A Whittlesey House Publication of the McGraw-Hill Book Company, 370 Seventh Ave., New York City; cloth, 409 pages; price $2.50—Dealing with the modern technique of concentration, memorizing, training and developing one's mental power, this book offers practical aid to those whose positions or ambition compel them to learn some new science, profession, trade or business.

INVESTIGATION OF VARIOUS FACTORS AFFECTING THE HEATING OF ROOMS WITH DIRECT STEAM RADIATORS. By A. C. Willard, A. P. Kratz, M. K. Fahnestock and S. Konzo. Bulletin No. 223 of the Engineering Experiment Station, University of Illinois, Urbana, Ill.; 102 pages; illustrations, charts and tables; price 55c.—Results of an extensive investigation undertaken in cooperation with the Institute of Boiler and Radiator Manufacturers and the Illinois Master Plumbers' Association.

ANHALTSZAHLEN FÜR DEN ENERGIEVERBRAUCH IN EISENHÜTTENWERKEN. Compiled by the Warmestelle Düsseldorf des Vereins deutscher Eisenhüttenleute. Third edition published by the Verlag Stahleisen, Breite Strasse 27, Düsseldorf, Germany; cloth, 119 pages, illustrations and charts; price RM 16.—Data on the power consumption in iron works, together with information on the iron-working machines, furnaces, etc.

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION, 420 Lexington Ave., New York City, has recently published three new booklets on electrical apparatus. One contains standard specifications for panelboards and distribution boards; 32 pages, price 50c. The second is a revised edition of the booklet on "Instructions for Care and Operation of Transformers," price 25c. The third covers revised standard dimensions, tolerances and specifications for vulcanized fibre sheets, tubes, rods and rolls; price 25 cents.

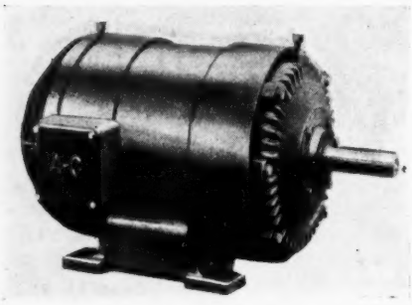
UNITED STATES NATIONAL COMMITTEE OF THE INTERNATIONAL ELECTROTECHNICAL COMMISSION, 33 West 39th St., New York City, has just issued a series of new publications, which include: "I.E.C. Rules for Electrical Machinery," covering generators, motors, converters, transformers, etc., price $1; "Graphical Symbols for Heavy-Current Systems," price $1; "I.E.C. Publication of the Testing of Hydraulic Turbines," price 50 cents.

WHAT'S NEW IN PLANT EQUIPMENT

Explosion-Proof Motor for Hazardous Atmospheres

EXPLOSION-PROOF motors for use in hazardous atmospheres were announced recently by the Allis-Chalmers Manufacturing Company, Milwaukee, Wis. These motors have been tested and approved by the Underwriters' Laboratories for use in Class 1, Group D locations.

The construction of the new motor is along the same general lines of the



Explosion-proof motor approved for use in Class 1, Group D locations

totally inclosed, fan-cooled motor built for some time by this company. Its special features include extra long bearing seals to prevent the escape of flame and to cool the gases below the point of ignition, special alloy-steel cap screws that fit into tapped pockets, and unusual sturdiness to resist safely stresses due to possible internal explosions or flashes. In addition to the sealed motor leads, a special explosion-proof cast-iron conduit box gives additional protection against possible contact with surrounding air.

Coal Spreader and Gasifier

THE PURPOSE of the Gebhardt coal spreader and gasifier, shown in the accompanying illustration, put out by the Gebhardt Company, Inc., 543 South Dearborn St., Chicago, Ill., is to so ridge the fuel bed on a chain grate that the volatile will be driven off quickly and burned under the arch, leaving a practically uniform bed of coke to be

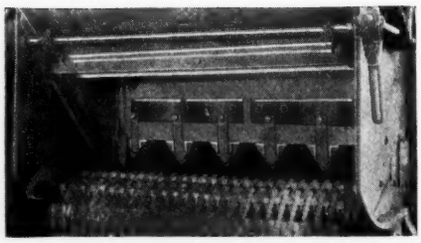


Fig. 1—Gebhardt coal spreader and gasifier applied to chain grate

carried through the furnace. The results obtained have been, improved smokeless combustion, increased capacities, and, owing to cleaner fires, longer life for the furnace refractories.

Heat-resisting metal spuds faced with suitably shaped refractory blocks are supported by cast-steel hanger bars attached to the front of the coal gate. Notched slots in the bars for the supporting bolts permit adjustment of the spud height. These arrow-shaped spuds form longitudinal ridges in the fuel bed as it passes under the gate. The top of the ridge may be 9 in. above the grate when the apex of the groove is 3 in. above it.

Through the thin bed of coal along the grooves much of the air for combustion passes to burn the coal on the sides of the ridges and mix with the volatile driven off by the heat of burning and the reflected heat from a properly designed arch. Mixed with air in proper proportion, the volatile gases ignite and burn readily, leaving a bed of coke to pass through the furnace. In the ridges the green coal expands, cokes and levels off into the grooves, giving practically a uniform fuel bed as the coke passes out from under the arch.

With the burning surface of the coal increased from 25 to 38 per cent, according to the width of the stoker, relatively large capacities are obtainable. It is claimed that with natural draft as much as 60 lb. of Illinois screenings have been burned per square foot of grate surface per hour.

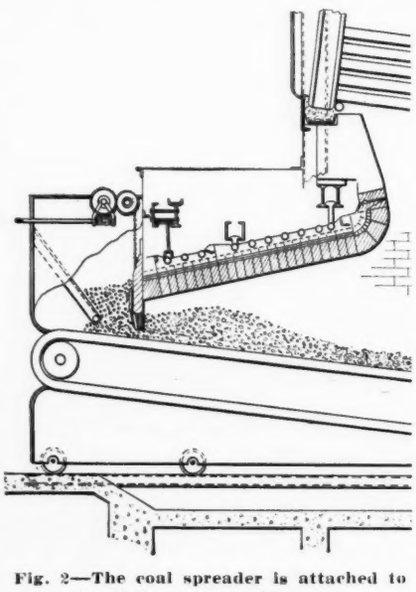
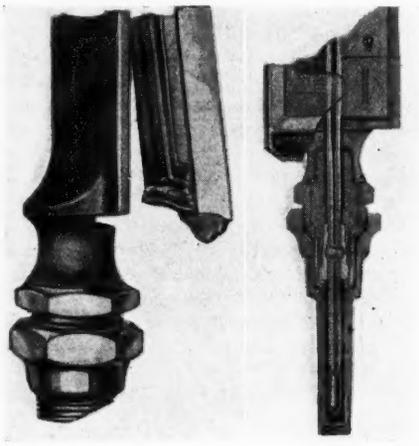


Fig. 2—The coal spreader is attached to the stoker gate as indicated

New Snap-Case-Front Industrial Thermometer

THE SNAP-CASE-FRONT on the new industrial thermometer recently brought out by C. J. Tagliabue Manufacturing Company, Brooklyn, N. Y., has been designed to make cleaning of the glass easy and at the same time to make breakage of the easily removable glass front almost impossible. A tongue at the top of the case fits snugly in a groove in the front so that in either opening or closing the front it cannot



Thermometer with front open and section showing bulb construction

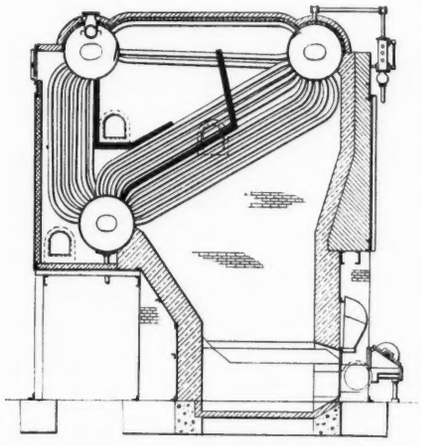
slip and fall. When in position on the instrument the front is held firmly closed by a snap device.

Other important constructional features of the new line include connecting piece locked to case by a specially designed split spring washer; asbestos packing uniformly compressed around enlargement on glass stem, preventing movement of the tube with reference to scale; monel-bulb chamber thin enough to allow quick conductivity, yet strong and non-corrosive; left-hand thread on bulb chamber prevents loosening if case is turned in removing thermometer from socket and mercury filling in bulb chamber completely surrounding bulb of thermometer insures rapid transmission of heat.

New Low-Head Bent-Tube Boiler

A NEW BENT-TUBE BOILER suitable for installations requiring low headroom has been designed by the Freeman Manufacturing Company, Racine, Wis. Of the three-drum type, the boiler is arranged to present the maximum of radiant surface to the fire. By making the furnace wider than usual and using long tubes in the front bank, furnace volumes are relatively large. Both of these features contribute to capacity and to the response of the boiler to sudden loads. The baffling is flexible, so that the arrangement may be varied for different methods of firing.

Circulation in this boiler is much the same as in a cross-drum type, a variation being the substitution of drums for the ordinary stayed headers. Feed water enters the upper rear drum and descends through a short economizer



Freeman low-head boiler

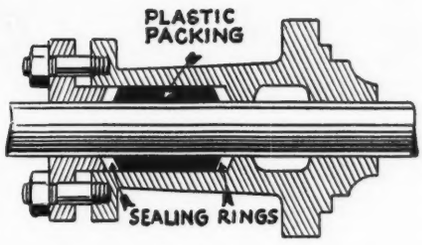
section to the mud drum. From this lower drum the water enters the main circulating bank, passing through the lower tubes to the upper front drum and returning through the upper tubes of the bank.

Precautions taken to insure dry steam are indicated in the drawing. The steam is liberated in the front drum. The turbulence from its liberation is confined there, as the steam must pass around a projecting baffle into the dry tubes, which deliver it to the rear drum.

These boilers are made in all sizes from 1,000 to 6,000 sq.ft. of surface, and for all methods of firing. Drum diameters range from 36 to 48 in. Headroom from the floor to the top of the steam nozzle varies upward from a minimum of 15 feet.

Plastic Metallic Packing and Gasket Material

TWO CLOSELY RELATED PACKING MATERIALS originating in Europe and in successful use for some time have been taken over by the A. & E. Company



Aeco metallic packing in stuffing box under pressure

540 North Michigan Ave., Chicago, organized recently to manufacture and market these products in the United States and Canada. One of these materials, known as "Aeco," is a plastic self-forming packing composed of porous all-metallic kernels, saturated with non-drying lubricants. The packing, it is claimed, will not dry out or harden, and owing to its plasticity it will accommodate itself to expansion, contraction and vibration. Being plastic, it can be made to fit any size of stuffing box. It is molded into cakes which, when broken up and placed in any stuffing box, form into a ring bearing around the rod when the gland is tightened. When refilling is necessary a little fresh packing is added to the old material, and by tightening the gland the mixture is again pressed into a solid ring.

The packing is made in several grades. One is designed for saturated steam, hot and cold water, air, gases, brine and liquid ammonia for temperatures up to 600 deg. F. A finer grade of the same material is used for bronze sleeves, valve stems, or where the diameter of the rod or shaft is less than 1 in. A third grade is prepared for tar, oil, gasoline and all petroleum products for temperatures up to 600 deg., and a finer mixture of this material for bronze and small diameter service in this field. Other grades are prepared for superheated steam temperatures up to 2,200 deg., for extra-heavy duty, or for special uses where corrosive substances are handled.

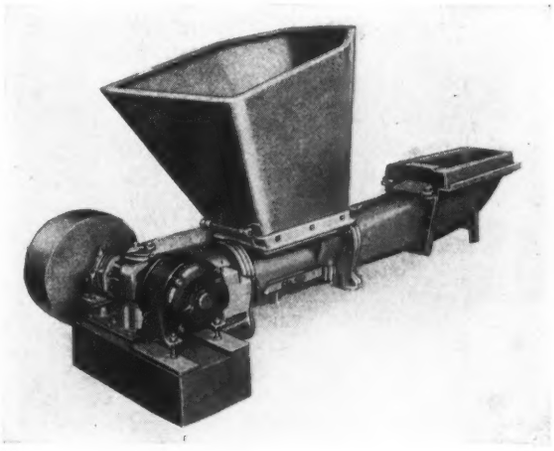
As a packing material for bolted flanges to replace ready-made gaskets "Plasket" is made in a number of grades. The uses designated are much the same as for the packing. Practically the same material, under the name of "Pipease," is supplied for threaded joints. Resembling a heavy putty-like mass, these materials are applied in a thin layer with a putty knife to the sealing surface. As in the case of the packing, it is said that "Plasket" will function under vibration and will withstand expansion and contraction of the adjacent parts. It is not affected by any of the substances with which it comes in contact, and because the material remains plastic indefinitely, the joint can be easily demounted at any time. These products come in cans of 1½ to 10 lb., or in larger lots in drums.

Small Underfeed Hydraulically Driven Stokers

ROUNDING OUT its line of stokers, the Auburn Stoker Corporation, Auburn, Ind., has added four small units particularly adapted for heating requirements between 1,500 and 7,500 sq.ft. radiation and for small power boilers.

All the important features of the large Auburn stokers are incorporated in the new smaller stoker, which consists of two units—the power unit, comprising the fan, motor and oil pressure pump, and the stoker unit, consisting of the hydraulic motor, ram, stoker throat, and the retort and tuyère assembly. In all sizes the deep retort carries the secondary pusher to aid in the distribution of the coal. Although the power unit is shown in place in front of the stoker, where space is limited it may be separated from the stoker unit and placed alongside or in any position adjacent to the stoker. The two units are then connected by means of piping. Flexibility in the control of the fuel bed is an outstanding feature of this type of drive.

In the stoker illustrated, the power unit is mounted on the oil supply tank and the pressure pump is equipped with the standard Auburn coal control and safety relief valve. This valve is set to bypass the oil pressure should the plunger become jammed as a result of blocks of wood or other foreign matter entering the stoker hopper with the coal.



Auburn small stoker for heating and for small power boilers

NEWS of the FIELD

Parliamentary Investigation Started of Beauharnois Development on St. Lawrence

INVESTIGATION by a special parliamentary committee into the Beauharnois Power Corporation's undertaking on the St. Lawrence River has commenced at Ottawa, Canada. Outstanding features of the proceedings to date have been a frank admission by the Beauharnois corporation's counsel that the company's detailed plans have never received the approval of the government; submissions by Peter White, chief counsel for the special committee, purporting to show a spread of $3,000,000 which went to the underwriters in connection with the Beauharnois Corporation's bond issue; a letter and evidence of Gerard Lacroix, a Quebec lawyer, which "retailed gossip" concerning senators and other promoters alleged to be behind the bill amending the company's charter when it was before the Quebec Legislature, and a statement by Aimé Geoffrion, counsel for the Beauharnois Corporation, in a letter to Hon. Charles Dunning, former minister of railways, accusing the rival interests which are suing Beauharnois for $10,000,000 in respect to an option from the original owners of the Beauharnois property, of falsehood.

In admitting that it had proceeded with the project in advance of authorization by the government, the corporation contended that such authorization was unnecessary, so long as the work undertaken did not interfere with the interests of navigation. The corporation is working within its own property and the only chance it is taking, according to counsel's argument, is that when construction is completed navigation will be found to be affected by the change in plans.

Duncan W. McLachlan, chairman of the Canadian section of the Joint Board of Engineers, revealed that the intake of the Beauharnois Canal had been moved 3,000 ft. from the location shown on the original plans without sanction from the Dominion Government, any department of the Government, or its engineers. He insisted that the present location of the intake should be changed as navigation in the vicinity, owing to dangerous cross-currents, would be extremely difficult, and the present arrangement was unlikely to meet with the approval of the American engineers on the Joint Board, which is dealing with the St. Lawrence waterway scheme.

Confirmation of Robert Gardiner's charge in the House of Commons that the Beauharnois Corporation had excavated a canal three times as wide as it had authority from the Government to construct was also forthcoming, in the report of federal engineers to Premier Bennett. That report shows that the first mile of the canal from the intake on Lake St. Francis now is 3,300 ft. wide instead of 1,100 ft. as authorized, while another section of the canal, which was to be 4,100 ft. wide, has been reduced to 3,400 ft., in width, all without government consent or approval.

Asked why the corporation had moved the intake, Mr. McLachlan said they had done it to avoid excavating rock, which was struck at the original location shown on the plans. Construction of the wider canal, he said, would curtail the navigation period in Montreal Harbour, and would involve considerable financial loss to shipping.

Boiler and Pulverizer Sales Decline; Stokers Increase

NEW ORDERS for 646 steel boilers of 572,681 sq.ft. were placed in May, according to reports submitted to the Bureau of the Census by 73 manufacturers comprising most of the leading establishments in the industry, as compared with 689 boilers of 825,203 sq.ft. in April and 1,283 boilers of 1,329,748 sq.ft. in May, 1930. The total sales for the first five months of this year amount to 3,079 boilers of 3,261,734 sq.ft., as compared with 5,092 boilers of 5,684,-205 sq.ft. for the corresponding period of last year.

Orders for pulverizers and pulverized-fuel equipment in May, as reported to the Bureau, aggregated 4 pulverizers having a total capacity of 4,300 lb. of coal for contract, as compared with 13 pulverizers with a total capacity of 118,250 lb. in April. Sales for the first five months of this year totaled 54 pulverizers with an aggregate capacity of 458,550 lb. of coal for contract.

May sales of mechanical stokers, as reported to the bureau by the eleven leading manufacturers, totaled 80 stokers of 23,646 hp., as compared with 65 of 18,723 hp. in April and 96 of 31,956

POWER was founded in 1884 by E. P. Harris and H. M. Swetland. With it was incorporated *Steam*, which had been started by N. Hawkins in Chicago two years earlier.

In 1903 *Power* purchased and absorbed *Science and Industry*, which was a consolidation of a number of periodicals, namely, *Home Study Magazine, Home Study for Machinists, Mechanic's Magazine, Home Study for Building Trades, Building Trades Magazine, Home Study for Electrical Workers* and *Steam Electric Magazine*.

In 1908 it absorbed *The Engineer's Review*, of Cleveland, and *The Engineer*, of Chicago, the latter being a consolidation of *The Safety Valve, Lord's Power and Machinery Magazine, The Stationary Engineer, Engineers and Power Users Magazine, Steam Engineering* and *The Mechanical Engineer*. When *The Engineer* was purchased the name of the combined paper was *Power and the Engineer*. The title was condensed to *Power* in 1911.

Ownership of *Power* passed from E. P. Harris to H. M. Swetland and James H. McGraw, then to John A. Hill; and with the consolidation of the Hill Publishing Company and the McGraw Publishing Company, in 1917, it became the property of the McGraw-Hill Publishing Company.

Robert Grimshaw was the first editor of *Power*. Subsequent editors for short periods were George L. Fowler, A. D. Risteen and Franklin Van Winkle. F. R. Low was editor from 1888 until Dec. 31, 1929.

The present staff consists of Ely C. Hutchinson, editor; F. R. Low, editor emeritus; A. D. Blake, managing editor; P. W. Swain, Thomas Wilson, F. A. Annett and L. H. Morrison, associate editors; A. L. Cole, R. B. Purdy, H. R. Clark and L. E. Driscoll, assistant editors.

hp. in May, 1930. New orders for the first five months of this year amounted to 359 stokers of 100,113 hp., as compared with 419 of 136,108 hp. for the corresponding period of last year.

Wisconsin Steam Plant To Be Completed Soon

THE NEW steam generating station of the Wisconsin Power & Light Company, which has been under construction for the past year, will be completed in the early part of September, according to a recent announcement of the company. The plant, which is located on a 175-acre tract of land south of Sheboygan and just north of the mouth of the Black River, is one of the few large plants of its kind on the Great Lakes.

Installation of the first unit, which was built by the Allis-Chalmers Company to have a capacity of 30,000 kw. at 80 per cent power factor, is practically complete, it is stated. The second unit, which will be installed at a later date and provision for which has been made, will be of the same size. The building and equipment are so designed as to provide further units of the proper size as the requirements increase. The plant building is of red brick construction with a steel and concrete framework.

California Oil Producers Try Cooperative Selling

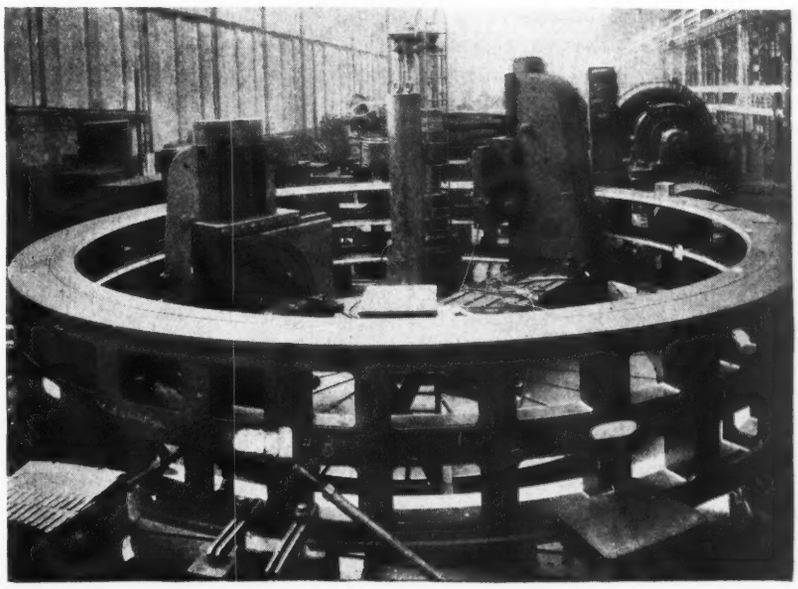
LAST MONTH the Oil Producers' Sales Agency of California, an organization of California independent oil producers, began to function as a sales agency by offering its products on the market. This is the first time that the sale of petroleum has ever been attempted through a cooperative marketing organization.

The new agency is a non-profit, cooperative group with no capital stock. Any producer of oil products, who has the same for sale, can become a member, and his membership fee, as well as his vote, is based on the per-day volume of his output. The output of all the members is entirely in the hands of the agency and it can sell the product to any one of the majors, or to any of the 60 independent refineries, at any time, and at any price obtainable, or it can sell a part of it and withhold the rest. The owner member has no voice in the sale of his output.

The purpose of this organization is to assist in solving the problems of deflated prices, overproduction and price wars. The curtailment in California has been in progress two years, with a fair degree of success. The per-day output of 792,500 bbl. in April, 1929, has been reduced to 527,000 bbl. in April, 1931, but there is still overproduction.

Another attempt being made to solve the difficulties now confronting the oil industry on the Pacific Coast is through the program suggested in the report of the California Oil Survey Committee. This committee is composed of a group of business men not actively connected with the oil industry. The committee found through its investigations that the present status of the petroleum industry in California is due primarily to overproduction of crude oil. The report recommends rigid curtailment with a firm market at current posted prices assured for all crude oil produced under the curtailment program.

WELDED FRAME FOR LARGE GENERATOR



A generator frame, recently completed at the Westinghouse East Pittsburgh Works, contains 82,000 lb. of steel, entirely fabricated by the electric welding arc. This frame, constructed in three sections, is 25 ft. in diameter, 67 in. high and is a part of a 66,700-kva. waterwheel-generator

▼ ▼ ▼

Completed Line Brings 40,000 Hp. to Hoover Dam

MAKING AVAILABLE electric power for the construction of the Boulder Canyon project and marking the completion of the first step in the work, A. B. West, president of the Nevada-California Electric Corporation, on behalf of its subsidiaries, The Southern Sierras Power Company and the Nevada-California Power Company, which built the 225-mile, 132-kv. transmission line from San Bernardino, on June 27 threw a switch which delivered 40,000 hp. at the dam site.

The ceremony of turning on the power followed an automobile tour of the district, including a visit to Boulder City, the reclamation construction camp, headquarters of the Six Companies, Inc., a boat trip down the Black Canyon Gorge, and an inspection of highway and railroad construction activities.

Canadian and U. S. Officials Favor St. Lawrence Project

STRONG SUPPORT of the completion of the St. Lawrence waterway to the sea was voiced by Canadian and United States officials during a recent gathering aboard the steamer Noronic. A plea for the speedy achievement of the international project was delivered by Senator Vandenburg, of Michigan, and a detailed analysis of its progress to date was given by Arthur Meighen, newly appointed commissioner of the Ontario Hydro Electric Commission.

Mr. Meighen admitted the feasibility of the proposed seaway and power project and said he believed that there would be no difficulty over the engineering problems yet to be discussed. Summarizing the agreements between the governments of Canada and the United States, Mr. Meighen noted that there was still some difference of opinion as to the order of procedure and the nature of the project itself.

"Canada is anxious to avoid assuming any insuperable financial burdens at present," he said. "She is anxious to develop the power resources of the St. Lawrence in consonance with the power of her people to consume it and she is unwilling that any of her share shall be exported. The United States, with more urgent power requirements, is insistent that the international section shall not lag behind. There are those who say that we will never yield an iota of our sovereign rights in the territory over which we have absolute dominion. That spirit can be carried too far," he concluded.

New England Power and Tenney Interests to Merge

NEGOTIATIONS are practically completed for the consolidation of the utility interests of the Tenney organization in Boston with those of the New England Power Association, a subsidiary of the International Hydro-Electric System, according to a joint statement of Frank D. Comerford, president of the New England company, and Charles H. Tenney, president of the North Boston Lighting Properties. One of the largest utility mergers of recent times, this combination has been under consideration for about two years, it is reported, but details of the stock transfer plan to be submitted to shareholders has only recently been completed.

The International Hydro-Electric System after the merger will serve a population of 4,250,000, the North Boston-Tenney interests serving cities and towns with a total population of more than 1,000,000. The number of international customers will be increased from 594,000 to 960,000 by the affiliation, it was stated.

British Columbia Company Plan 157,000-Hp. Project

A HYDRO-ELECTRIC PROJECT with a capacity of 157,000 hp. is planned by the British Columbia Electric Railway Company, which has placed the scheme for development of the Campbell River on Vancouver Island before the provincial water board.

If the scheme is approved by the board, three large power plants will be built, the first at Elk Falls having a maximum of 93,500 hp. with 71,000 hp. continuous supply at all times, the second at Trout Pool with 18,000 hp. maximum and 14,000 continuous supply, and the third at Lower Campbell Falls where a maximum of 45,600 hp. would be developed.

The scheme in its entirety would require extensive damming and tunneling, and would necessitate the raising of a lake in park land to a maximum height of 32 feet.

Charles Cullen Dies

CHARLES CULLEN, for many years a representative of the Wm. Powell Company, Cincinnati, Ohio, died on June 25 in Latonia, Ky. Mr. Cullen had been continuously associated with the Powell company since 1891, during which time he had acquired a wide circle of friends and acquaintances among dealers, jobbers and operating engineers in the power field. He was well known by those who attended the many conventions of the N.A.S.E.—now the National Association of Power Engineers—at which he was always in charge of the Powell exhibits.

COMING CONVENTIONS

American Society of Mechanical Engineers. Regional meeting in Kansas City, Mo., Sept. 7-9. Annual meeting in New York City, Nov. 30-Dec. 4. Secretary, Calvin W. Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers. District meeting at Lake Tahoe, Calif., Aug. 25-28. District meeting at Kansas City, Mo., Oct. 22-24. Secretary, F. L. Hutchinson, 33 West 39th St., New York.

American Welding Society. Fall meeting at the Copley-Plaza Hotel, Boston, Mass., Sept. 21-25. Secretary, M. M. Kelly, 33 West 39th St., New York City.

Association of Edison Illuminating Companies. Forty-seventh annual meeting at The Greenbrier, White Sulphur Springs, W. Va., Sept. 21-25. Secretary, Preston S. Millar, 80th St. and East End Ave., New York City.

International Railway Fuel Association. Annual convention at the Hotel Sherman, Chicago, Ill., Sept. 15-16. Secretary, C. T. Winkless, Room 700, La Salle Street Station, Chicago, Ill.

National Association of Power Engineers. Annual convention and mechanical exposition in the Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago.

Southwest Power Conference and Show will be held in Convention Hall, Kansas City, Mo., Sept. 7-11. Secretary, George F. Klein, Chamber of Commerce, Kansas City, Mo.

Third International Conference on Bituminous Coal. At Carnegie Institute of Technology, Pittsburgh, Pa., Nov. 16-21. Chairman, Thomas S. Baker, president of Carnegie Institute of Technology.

Universal Craftsmen Council of Engineers. Annual convention at the Sherman Hotel, Chicago, Ill., Aug. 4-8. Secretary of Convention Committee, James J. Blaine, 7342 Harvard Ave., Chicago, Ill.

J. E. Starr, Refrigeration Engineer, Is Dead

JOHN EDWIN STARR, refrigeration engineer and president of the Starr Engineering Company, New York City, died on June 27 at his home in Long Island. He was 71 years old, a native of Litchfield, N. Y.

For the last 30 years Mr. Starr had specialized in refrigeration engineering. He was the inventor of a low-temperature machine which attains temperatures of 30 to 75 deg. F. below zero and of several absorption refrigerating devices. He had contributed articles to *Power*, *Ice and Refrigeration*, *The Refrigerating World* and *Ice*.

He had served as president and vice-president of the American Society of Refrigerating Engineers and was a member of the American Society of Mechanical Engineers and the Engineers Club.

Personals

W. P. HAMMOND, after an absence of four years, has returned to the Georgia Power Company as chief engineer. Mr. Hammond, who entered the employ of the company in 1913, is the designer of Plant Atkinson, Furman Shoals hydro-electric plant, Burton dam, Tugalo, Nacoochee, Terrora and Yonah developments. In 1927 he was transferred to Birmingham as engineer with the Southeastern Engineering Company, a subsidiary of the Southeastern Power & Light Company. Later he became generating station engineer of Allied Engineers, Inc., with headquarters in Birmingham.

CHARLES C. MOORE, for nearly 30 years president of C. C. Moore & Company Engineers, Inc., of San Francisco, Calif., has retired from active participation in the management of the business and has become chairman of the board. ELGIN STODDARD, who has been vice-president of the company for approximately 25 years, succeeds Mr. Moore as president.

ROGER B. MCWHORTER, of Alabama, took the oath of office on June 27 as chief engineer of the Federal Power Commission. Prior to his recent appointment to the Power Commission, Mr. McWhorter was serving as principal engineer of the Great Lakes division of the Army Corps of Engineers.

GEORGE R. WRIGHT, of the Canadian General Electric Company, was recently elected chairman of the Vancouver Section of the American Institute of Electrical Engineers, with CLARENCE ARNOTT, British Columbia Electric Railway Company, secretary, and Prof. HERBERT VICKERS, University of British Columbia; F. J. BARTHOLOMEW, Electric Power Equipment, Ltd.; and L. B. STACEY, Packard Electric Company, members of the executive committee. The office of chairman also includes that of chairman of the general committee appointed to prepare for the Pacific Coast convention of the national body, which will meet in Vancouver during Sept., 1932.

O. P. COTTRELL, manufacturing manager for the Associated Oil Company, has been appointed to take over management of the interests in the United States of the Edeleanu Company, Ltd. Mr. Cottrell first entered the petroleum industry in 1917 as research chemist for the Tide Water Oil Company, and during 1922 he was sent East and concluded negotiations with Dr. EDELEANU which brought the Edeleanu oil refining process to the Associated Oil Company.

A. D. HUNT, former manager of engineering at the South Philadelphia works of the Westinghouse Electric & Manufacturing Company, has been transferred to the company's Chicago office, where he will be engaged in steam apparatus activities in that district.

Business Notes

BABCOCK & WILCOX COMPANY, New York City, are observing this year the 50th anniversary of the incorporation of the company. Founded in 1867 as a partnership of George H. Babcock and Stephen Wilcox, the corporation was formed on April 1, 1881. To commemorate the occasion, the company has published an interesting book, entitled "Fifty Years of Steam," which gives a brief history of its development and the part it has played in the growth of power.

BLAW-KNOX COMPANY, Pittsburgh, Pa., announces the appointment of Roger W. Andrews, now assistant to the president, as vice-president and director of the Blaw-Knox International Corporation. Mr. Andrews will reside in Paris and will be in charge of the company's European activities, which, it is stated, have been growing considerably in the past few years. He will take the place of C. T. Clack, who died recently in Düsseldorf, Germany.

ELLISON DRAFT GAGE COMPANY, Chicago, Ill., announces the appointment of the Craun-Liebing Company, 30 Euclid Arcade, Cleveland, Ohio, as exclusive representative in the Cleveland territory, including northeastern Ohio.

UNION CHAIN & MANUFACTURING COMPANY, Sandusky, Ohio, announces the appointment of the Industrial Gear & Machine Works, 225 Sixth Ave., Oakland, Calif., as exclusive distributors in that territory.

GOULDS PUMPS, INC., Seneca Falls, N. Y., announces the following changes in the staffs at headquarters and the branch offices: Henry L. Boyer is now manager of farm-suburban sales; Henry F. Miller, manager of industrial sales; W. G. Allen, manager of engineering sales; J. B. Anderson, in charge of the department of inquiry and estimate; G. W. Cramer, advertising manager; Mark D. Rowe, formerly Eastern manager of Servel Sales, Inc., is now manager of Goulds New York office; J. B. Foley, formerly manager of the Pittsburgh office, is now in charge of the Chicago office; and Fred Jones, formerly manager of the Philadelphia office, is now manager of the Pittsburgh office. The company also announces the opening of a branch office at 417 Magnolia Bldg., Dallas, Tex., with Fred Hayes manager.

GENERAL HEAT AND POWER CORPORATION, New York City, has appointed the Jarvis Engineering Company, 51 Ellery St., South Boston, Mass., as distributors in New England, and the Combustion Utilities Corporation, 4531 North Broad St., Philadelphia, Pa., for the Philadelphia district.

LUKENWELD, INC., a division of the LUKENS STEEL COMPANY, Coatesville, Pa., has appointed W. R. McDonough & Company as representatives in the Cleveland district, and the Dravo Doyle Company as representative in the Pittsburgh territory.

How's Business?

AS THE SECOND HALF begins the business outlook oscillates uncertainly in the sensitive balance of sentiment. The psychological stimulus of the moratorium and other emergency efforts to ensure stability in the situation abroad has slackened. Security and commodity markets have sagged or are marking time till favorable news offers further nourishment for enthusiasm. Meanwhile business indicators, except in certain sensitive retail lines, still register no concrete effect of increased confidence. Our index, estimated early on preliminary figures for the last week of June, indicates a further recession, reflecting intensified seasonal contraction of activity. Still it is increasingly evident that the explosive materials for a major upswing of surprising speed and proportions are accumulating in the unprecedented credit position of the Reserve system, the curious currency situation, the continued imports of gold, the abnormally unbalanced condition of commodity stocks.—*The Business Week*, July 8.

Trade Catalogs

CONVEYORS—A new catalog on elevating and conveying machinery has been issued by the Freeman-Riff Company, Terre Haute, Ind., which contains descriptions and illustrations of coal- and ash-handling installations.

HEAT INSULATION—"Conquering Deepwater's Heat Insulation Problem," is the title of an illustrated bulletin recently issued by the Keasby & Mattison Company, Ambler, Pa. The bulletin gives an interesting account of the experiences encountered in the prevention of heat losses in the Deepwater (N. J.) high-pressure power plant.

BEARINGS—A description of the Robins-Jones oil-lubricated babbitt bearing is contained in a new bulletin (No. 81) of the Robins Conveying Belt Company, 15 Park Row, New York City. Full details of construction are given, together with illustrations of actual installations.

BELT DRIVES—L. H. Gilmer Company, Tacony, Philadelphia, Pa., has just issued a new 84-page catalog on V-belts. It comprises two sections, the first devoted to theoretical and practical illustrations of V-belt drives and the second section containing detailed engineering information and data.

INSTRUMENTS—Catalog No. 1101, just issued by the Brown Instrument Company, 4504 Wayne Ave., Philadelphia, Pa., contains in its 48 pages an illustrated description of the new line of potentiometer pyrometers recently introduced by the company.

HEAT-TRANSFER EQUIPMENT—Many types of condensers, coolers, heat exchangers, heaters and evaporators used in process work are illustrated in a new bulletin (Form 479) issued by the Griscom-Russell Company, 285 Madison Ave., New York City.

PULVERIZED-COAL BURNER—Bulletin No. 905, just issued by the Fuller Lehigh Company, 85 Liberty St., New York City, describes and illustrates the application, construction and operation of the company's circular burner, a pulverized-coal burner of the turbulent type.

▼

Fuel Prices

FUEL OIL

Boston—June 29, tank-car lots, f.o.b. 12@14 deg. Baumé, 2.9c. per gal.; 28@32 deg., 4.83c. per gal.

New York—July 2, f.o.b. Bayonne, N. J., 28@34 deg. Baumé, industrial use, tank-car lots, 4c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 5c. per gal.

Philadelphia—June 25, No. 3, industrial gas oil, $1.83 per bbl.; No. 4, light industrial fuel oil, $1.31 per bbl.; No. 5, medium industrial fuel oil, $1.20 per bbl.; No. 6, heavy (Bunker C), $1.05 per bbl.

Pittsburgh—June 24, f.o.b. local refinery, fuel oil, 30@34 deg., 2.5c.@2.625c. per gal.; 36@40 deg., 2.5c.@2.625c. per gal.

Cincinnati—June 30, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.5c. per gal.; 26@30 deg., 4.75c. per gal.; 30@32 deg., 5c. per gal.

Chicago—June 17, tank-car lots, f.o.b. Oklahoma; freight to Chicago, 90c. per bbl. or 42 gal.; 18@22 deg., 30c. per bbl.; 22@24 deg., 35c. per bbl.; 24@26 deg., 40c. per bbl.; 26@28 deg., 47.5c. per bbl.; 28@30 deg., 55c. per bbl.

St. Louis—June 22, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.095 per bbl., or 42 gal.; 26@28 deg., $1.17 per bbl.; 28@30 deg., $1.245 per bbl.; 30@32 deg., $1.345 per bbl.; 32@36 deg., gas oil, 2.526c. per gal.; 38@40 deg., distillate, 3.151c. per gal.

Dallas—June 27, f.o.b. local refinery 24@26 deg., 70c. per bbl. or 42 gallons.

COAL

Bituminous (Net Tons)	At Mine, for Shipment to	Price per Ton
Pool 9, super low-vol.	New York...	$1.65 @$1.85
Pool 10, h. gr. low-vol.	New York...	1.50 @ 1.65
Pool 11, low-vol.	New York...	1.40 @ 1.50
Smokeless, mine-run	Chicago...	1.50 @ 1.75
Smokeless, slack	Chicago...	.60 @ 1.10
Harlan, Ky., slack	Chicago...	.85 @ 1.10
Franklin, Ill., mine-run	Chicago...	2.15
Franklin, Ill., screen	Chicago...	1.25 @ 1.75
Ind. 5th Vein, m.-r.	Chicago...	1.20 @ 1.75
Standard Ill., mine-run	St. Louis...	1.25 @ 1.40
W. Ky., mine-run	Louisville...	.85 @ 1.25
W. Ky., slack	Louisville...	.60 @ .85
Pittsburgh, mine-run	Pittsburgh...	1.35 @ 1.45
Smokeless, mine-run	Cincinnati...	1.65 @ 1.75
Smokeless, slack	Cincinnati...	.75 @ 1.25
Kanawha, mine-run	Cincinnati...	.90 @ 1.25
Kanawha, nut-slack	Cincinnati...	.50 @ .90
Anthracite (Net Tons)	At Mine, for Shipment to	Price per Ton
Buckwheat	New York...	$3.10 @$3.25
Barley	New York...	1.00 @ 1.40

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ariz., Douglass—Arizona Edison Co., W. C. Hornberger, V. Pres. and Gen. Mgr., Homebuilders Bldg., Phoenix, plans converting artificial gas plant and system to use natural gas here. Estimated cost $75,000.

Calif., Beverly Hills—City Clk., will receive bids until July 14, for furnishing and installing booster pumping plant at Melrose plant.

Calif., Los Angeles—University of Southern California, West 35th St. and University Ave., is having preliminary plans prepared for the construction of a 4 story library building including water treatment system, electric refrigerating system, heating and ventilating systems, electric elevators, etc. at 3563 New Hoover St. Estimated cost $780,000. Cram, Ferguson & Lunden, 400 Rowan Bldg., are architects.

Calif., Oakland—Oakland Laundry Co., 730 29th St., plans the construction of a power house and equipment in connection with new laundry plant. Estimated cost $200,000.

Ind., Fort Wayne—St. Vincent's Parish, will receive bids until July 10, for the construction of a church, orphans home, power plant, etc. at Wells and Archers St. Estimated cost $500,000. A. M. Strauss, 415 Cal-Wayne Bldg., is architect.

Ind., South Bend — Notre Dame University, has plans prepared for addition to power plant. Estimated cost $50,000. A. Kahn Inc., Marquette Bldg., Detroit, Mich., is engineer.

Ia., Des Moines—Northwestern Bell Telephone Co., H. G. Conger, Mgr., 3404 Iola St., is having preliminary plans prepared for the construction of a telephone exchange building including automatic switching equipment, etc., at 4201 Kingman Blvd. Estimated cost $1,125,000. J. Normile, 203 Hubbell Bldg., is architect.

Ia., Glidden—City plans extensions and improvements to electric light and power plant including additional equipment, etc. Estimated cost $60,000.

Ky., Paris—City awarded contract for the construction of a large dam across Stoner Creek near site of former Spears mill dam, also changes and additions to filtration and pumping plant to Clark, Stewart & Wood, Lexington; other changes and additions to pumping plant and filtration and settling basins to Higgins Construction Co., Charlotte, N. C.

La., Lake Charles — Lake Charles Compress Co., awarded contract for four new cotton warehouse compartments, classing shed, compress building and boiler room to J. A. Petty & Sons Inc., Godchaux Bldg., New Orleans. $58,777.

Mass., Monson — Commonwealth of Massachusetts, Dept. of Mental Diseases, W. A. Merrill, is receiving bids for the construction of a heating plant, cold storage plant, boilers, electric stoker operation, etc. Estimated cost $300,000. E. C. Brown Co., 77 Summer St., Boston, is engineer.

Mass., Newton—City, C. C. Chadwick, Comr. of Public Works, will receive bids until July 15, for the construction of a city hall and memorial building including heating and ventilating systems, etc. at Commonwealth Ave. and Walnut and Homer Sts. Estimated cost $1,000,000. Allen & Collens, 75 Newbury St., Boston, are architects. French & Hubbard, 210 South St., Boston, are engineers.

Mass., Westfield—Dept. of Public Health, State House, will receive bids until July 9, for the construction of a sewerage pumping station, blow-off tank, etc. at Westfield State Sanatorium. Estimated cost $40,000. Private plans.

Mass., West Roxbury — Town of Brookline, awarded contract for alterations to municipal pumping station at 260 Gardner St. to D. L. MacFarlane, 203 Jefferson St., Dedham, Mass. Estimated cost $40,000.

Mich., Olivet—Bd. of Trustees, Olivet College, will soon start work on a new power house. Estimated cost $35,000. Bowd & Munson, Lansing, are engineers.

Mich., St. Joseph—City awarded contract for furnishing and installing pumps, motors and reserve engine for pumping plant and filtration system to American Mill Works, Aurora, Ill. $11,760.

N. J., Irvington—Public Service Electric & Gas Co., Terminal Bldg., Newark, will build electric sub-station on Springfield Ave. here. Estimated cost $115,000. Private plans.

N. J., Paterson—Great Atlantic & Pacific Tea Co., Sherman Ave., awarded contract for a 1 and 2 story addition to warehouse at Railroad and 5th Aves. to Austin Co., 120 Broadway, New York, N. Y. Estimated cost $150,000. Contract not yet awarded for steel stack, boilers, refrigeration, incinerators, etc.

New York and New Jersey—Port of New York Authority, J. F. Galvin, Chn., 8090 8th Ave., New York, will receive bids until July 20, for electrical equipment and installation on Kill van Kull Bridge between Bayonne, N. J. and Port Richmond, N. Y.

N. Y., Brooklyn—Long Island Storage Warehouse Inc., Nostrand and Gates Aves., plans the construction of an ice skating rink, including refrigeration, etc. at Coney Island Ave. and Ocean Parkway. Estimated cost $125,000. H. G. Wiseman, 33 West 42nd St., New York, is architect.

N. Y., Long Island City — Constructing Quartermaster, War Dept., Mitchell Field, will receive bids until July 23, for a group of buildings including headquarters and operations building, parachute building, photographic laboratory, radio building, two boiler houses, etc. at Mitchell Field.

N. Y., New York—Bankers Trust Co., 14 Wall St., awarded contract for the construction of a 30 story bank and office building at 14 Wall St. to Thompson-Starrett Co., 250 Park Ave. Estimated cost $10,000,000. Contractor will receive separate contract bids about Sept. 1.

N. Y., New York — Dept. of Hospitals, Municipal Bldg., awarded contract for converting two 250 hp. water tube boilers for pulverized fuel firing in boiler room at Lincoln Hospital to Kennedy Van Saun Mfg. Co., 2 Park Ave., $44,856.

N. Y., New York—Consolidated Gas Co., 4 Irving Pl., plans the construction of a 3 and 5 story, 85 x 195 ft. generator house at Hunts Point Ave. and Bronx River. Estimated cost $500,000. J. F. Hunter, 4 Irving Pl., is architect.

O., Lisbon—City Council is having estimates made for the construction of a municipal electric light and power plant.

Pa., Canonsburg — Citizens Water Co., 62 East Wheeling St., Washington, subsidiary of Community Water Service Co., 46 Cedar St., New York, N. Y., is receiving bids for the construction of an impounding dam and spillway, 200,000,000 gal. capacity, etc. in connection with waterworks. D. C. Morrow, 62 East Wheeling St., is engineer.

Pa., Sharpsburg — City Council, is having surveys made for extensions and improvements to municipal electric light and power plant. B. R. Shover, Oliver Bldg., Pittsburgh, is engineer.

R. I., Providence—Dept. of Public Works, City Hall, will soon award contract for the construction of a booster pump house. S. F. Nolan, City Hall, is engineer.

Tenn., Memphis — Bd. of Water Commissioners, will receive bids until July 15, for the construction of James Sheahan water pumping station including wells, Layne & Bowlers electric pump, etc. at Normal State Teachers College, Normal. Estimated cost $2,000,000. Fuller & McClintock, McCall and South Front Sts., Memphis, are engineers. T. H. Allen, McCall St., Memphis St., Memphis, is associate engineer.

Tex., Gladewater—City is receiving bids for waterworks improvements including well, pump house, mains, etc. Estimated cost $25,000. F. J. Von Zuben, Don Waggoner Bldg., Fort Worth, is engineer.

Man., Winnipeg—British Dominions Power Syndicate, R. Morison, Pres., plans the construction of a power plant on Nelson River at White Mud Falls here. Initial cost $1,000,000.

Que., D'Israeli—Shawinigan Water & Power Co., 107 Craig St. W., Montreal, plans the construction of a hydro-electric development on Upper St. Francis River here. Initial cost $500,000.

B. C., Kamloops — Dept. of Public Works, plans remodeling present power plant including resetting two existing boilers and installation of new high pressure return tubular boiler and new steam driven coal stoker, etc. at Tranquille sanatorium near here. Estimated cost $40,000.

Que., Lake St. John — Price Bros. Ltd., Quebec City, plans the construction of a dam on Little Mistook River in Garnier Township. Estimated cost $250,000.

Equipment Wanted

Engine—Alpine, N. J.—Palisades Interstate Park Commission, 141 Worth St., New York, N. Y., will receive bids until July 13, for 50 hp. gasoline hoisting engine complete with three drum power hoist for Alpine storehouse here.

Pump—Anaheim, Calif.—City, E. B. Merritt, Clk., will receive new bids soon for a deep well turbine pump and motor for waterworks. Former bids rejected.

Pumps — Port Elizabeth, Que. — Municipal Council, will receive bids until July 23, for supply and erection of centrifugal sewage pumps, automatically controlled by float control apparatus and directed coupled to electric motors together with sluice valves, controls, etc. for Baakens Valley main sewerage.

Pumps and Electric Motors — Sydney, New South Wales, Australia—Dept. of Public Works, will receive bids until Aug. 31, for erection, operation and maintenance of two vacuum pumps and electric motors for Sowest Tablelands water supply.

Industrial Projects

Calif., Alameda — Owens-Illinois Glass Co., 133 Kearny St., San Francisco, is having plans prepared for the construction of a glass factory on Fernside Tract here. Estimated cost $1,500,000. Private plans.

Calif., San Jose—San Jose Cement Co. Ltd., E. H. Dettner, Pres., 835 Howard St., San Francisco, awarded contract for the construction of a cement plant here, 3,500 bbl. initial capacity to Hunt-Mirk & Co., 141 2nd St., San Francisco, engineers. Estimated cost $2,250,000.

Me., West Peru—Berst, Foster, Dixfield Co., F. W. Smith, Mgr., awarded contract for the construction of a power house and pump house to J. H. Kerr, Prospect Ave., Rumford. Estimated cost $40,000.

Mass., Taunton — Taunton Pearl Works, 35 Vernon St., awarded contract for addition and alterations to factory on Vernon St. to L. J Young, 469 Cohannet St. Estimated cost $50,000.

Neb., Omaha—Grant Storage Battery Co., 1309 Jones St., manufacturers of electric storage batteries, plates, etc., plans to rebuild part of factory destroyed by fire. Estimated cost $40,000.

N. J., Maplewood—Kroydon Co., Burnet Ave., postponed construction of 1 story addition to factory for the manufacture of golf clubs. Estimated cost $40,000. D. A. Hopper, 22 Ridgewood Ave., Irvington, Archt. Maturity indefinite.

Pa., Bradford—Kendall Refining Co., Kendall Ave., awarded contract for the construction of a cracking unit to A. G. McKee & Co., 2422 Euclid Ave., Cleveland, O. Estimated cost $350,000.

Pa., Philadelphia — Pennsylvania Sugar Co., Delaware Ave. and Shackamaxon St., plans the construction of a 5 story, 70x74 ft. power house. Estimated cost $70,000.

Tex., Cuero—Cuero Bag Awning & Tent Co., plans the construction of a 1 story, 60 x 110 ft. factory on West Main St. Private plans. Equipment to cost $12,000 will be purchased.

Wis., Ashland—Pittsburg & Ashland Coal & Dock Co., has work under way on the construction of a briquetting plant. Estimated cost $250,000. Maturity Nov. 1.

B. C., Vancouver Island—Lone Star Timber & Pulp Co., D. A. Grover, Gen. Mgr., Seattle, Wash., plans the construction of a pulp mill, veneer mill, shingle mill, etc. on east side of harbor at Port Renfrew here. Estimated cost $6,000,000.